UNIV. OF
TORONTO
LIBRARY

1557

Engineering and

ESTABLISHED 1886

Contract Record and Engineering Review

Published Ea Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOU G, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Grry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, 2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 January 7, 1914 **No. 1**

Principal Contents

Page
The Awakening of the Clay Industry 1
Increased Consumption of Water following Filtration. 2
Montreal's Mishap 2
The Engineer and the Accountant 3
Engineering Topics in the Old Land 4
Proposed Canadian Institution of Municipal Engineers.
Need for Central Authority to Control Municipal Borrowing.
Constructional Features of the New Dominion Bank, Toronto—Progress Article 6
Designing for the Future 8
New Residence for the Lieutenant-Governor of Ontario. 9
Explosives and Their Use in Excavation Work for Buildings 10
Economies in Contracting Operations 14
Water-Bound Macadam Roads 16
Advantages of Reinforced Concrete in Factory Buildings. 18
Imperfect Plans and Specifications 19
What Advertising Means t e Contractor 20
Contract Conditions at V ver 22
Conduit Work in a Firep Building 23
Letters to the Editor 24
"Educational Facilities fo Clayworker."
The Successful Tenderers Vancouver's Thirty-Million-Dollar Contract 25
H. Talbot-Crosbie—Biog l Sketch 26
Constructional News 27-8

A Table of Contents

COMMENCING with this the first issue of the New Year, the advertising and editorial pages of the Contract Record and Engineering Review will be numbered separately and the principal contents indexed. The increased percentage of our readers who make a careful and systematic reading of the journal has rendered it highly desirable for us to provide a means of ready reference, and we believe that a weekly index and separate page numbering, taken in conjunction with an annual index of contents, will greatly enhance the value of the publication, especially to those, whose number is also increasing, who bind their copies.

The year with the unlucky terminal numbers has passed into history and we have entered upon the Year of Grace, Nineteen Hundred and Fourteen. We feel sure that in the constructional field there will be great achievements to record and we are determined to keep pace with our readers in the march of progress. The record of achievement must be made through a medium which is a credit to the progressive interests it serves. It is the policy of the publishers to strive to make the Contract Record pre-eminent in its field and to introduce from time to time such improvements as will make the journal regarded as a standard. The policy which has been in evidence in the immediate past will be maintained on more aggressive lines, special attention being devoted to the more practical features of large constructional operations. The municipal field will be covered carefully, particularly in regard to developments in design, construction, operation and equipment.

We wish our readers all prosperity during 1914 and bespeak their continued co-operation.

The Awakening of the Clay Industry

EDUCATIONAL facilities for the clayworker, discussed editorially at some length in our issue of December 10, 1913, would appear to be a live issue, judging by the correspondence on the subject published elsewhere in this issue and also by the announcement that the Canadian Clay Products Manufacturers' Association has concluded arrangements for the equipment of an up-to-date clayworking department in the new technical school. This is an excellent beginning and it is to be hoped that it will stimulate other educational authorities into action. Doubtless many interesting details will materialize at the forthcoming annual convention of the Association, but we are sure that the equipment of the new department at Toronto will be thoroughly up-to-date and that the requirements of all will be met by the proposed programme of a regular course of ceramics, extending over perhaps two or three years, and a short winter term of two or three months at practical work.

It is evident from President Falconer's letter, published in this issue, that the University authorities were favorably disposed towards a course of ceramics, but in spite of the fact that progressive men closely identified with the industry promised financial assistance—in one instance to the extent of furnishing a complete laboratory and in another to bearing part of the expense of the general administration—the question of ways and means proved an insurmountable obstacle.

Competition is on the increase and aggressive measures must be taken to meet it. The monopoly of trade

1345P 1/10/14

TA
1
E 54
V. 28
pt. 1

enjoyed by some of our manufacturers during the early stages of Canada's development is explained by the fact that the possibilities of the country were not adequately recognized. Now our business is on a more substantial basis and we must advance with the times or yield our part to others.

England is awakening to the importance of providing well-equipped schools for clayworkers. Germany, the leader in all spheres of technical education, has some half-dozen excellent schools, and our neighbors to the south recognize clayworking as a subject of university education. What is the attitude of Canada? In what category shall we place the achievement—or lack of achievement—of the last few years?

Now that the national association—thanks to its live president, Mr. Charles A. Millar, and others with whom he has associated himself—has shown itself capable of acting as well as talking, and of producing something more tangible than "papers" and menu cards, it will most certainly come into wider recognition and take a higher place among the trade and technical bodies of the Dominion. It is to be hoped that this will be but the first chapter of a long history of achievement and that before many years the facilities at the command of clayworkers throughout the country will be second to none. It is with the greatest pleasure that we extend our congratulations to the Association.

Increased Consumption of Water following Filtration

PROBLEMS encountered in the design, construction and operation of filtration plants have been the subject of no little discussion of late. The subject is brought to mind by a visit received last week from Mr. Allan Hazen, the New York engineer who designed the Toronto plant. We understand that Mr. Hazen is now arranging to proceed against the city to obtain compensation for its failure to entrust him with the extension of the plant and the discharge of its obligations in regard to the original design. Our Chicago contemporary, Engineering and Contracting, makes some interesting editorial observations respecting this plant, emphasizing particularly the unprecedented increase in water consumption which has taken place in Toronto since the fall of 1908 when the plant was designed. At that time the average total daily consumption of water was 30,000,000 Imperial gallons, a figure which increased to 44,700,000 Imperial gallons during the year 1912. To quote from our contemporary:

"We have before called the attention of engineers to the advisability of making allowance for the increased consumption of water following the installation of a filtration plant. This increase is due partly to new consumers, attracted by the improved quality of the public supply, and to the greater domestic use of water when mineral table waters are supplanted by the public supply. The increased consumption at Toronto is so enormous that it can only be partially attributed to the causes mentioned and, in fact, the high rate of increase in the consumption of water began at the time the filters were being designed which was three full years before the plant was ready for even intermittent operation. While evidences of progress toward the installation of filters can hardly be said to increase the use of water the actual installation certainly does. The new rapid sand filter at Minneapolis affords a good example of this. Designed of capacity suitable for a consider le period in the future it had not been in operation ver six months before it was overloaded and extensi s are now being planned. This was due, again, to a ra of increase in water consumption which hardly co d have been anticipated. This tendency toward increa d consumption following the introduction of filtration ndicates not only the desirability of taking this prob ble increase into account in proportioning the plant, b t also shows the importance of keeping meterage a reast of filtration; cities having filtered supplies sh ld be fully metered as soon as practicable."

Montreal' Mishap

SHARP criticism of the ontreal Engineering Department has been h rd as the result of a big break in the reinforc concrete conduit supplying Montreal with ater. The break caused enormous inconvenience to he great majority of the inhabitants of the city, as th y depended upon the conduit for the supply of wat , and the break meant a discontinuance of the supp . Many industrial firms were also hampered, and the arge shops of the C. P. R. at Angus were temporarily shut down. The conduit was constructed from plans y Mr. G. Janin, the city's chief engineer, in 1908, the ontract being let to Mr. P. McGovern, of Boston, at cost of about $685,000.

The break which cause the water to be shut off was 60 feet long. The dam e was repaired by cutting out the defective length of ncrete and inserting steel pipes manufactured by the hn McDougall Caledonian Ironworks Company, Li ited, Montreal, as a rush order. These were joined, means of brick and tar, to the ends of the concrete nduit. cement being also used in the interior. Unfo nately however, the job was not a success. The wa r was let in very slowly, but the pressure was too rong, and the joint of bricks, tar, and cement gav way, with the result that the supply had to be again ut off.

When the serious chara er of the first break became apparent the Contro rs called in Mr. J. A. Jamieson, who conducted examination of the interior of the conduit. The tlas Construction Company were also called into a st in the work of repairing the concrete work.

Naturally, there were so e strong opinions heard, and Mr. Janin was criticised dversely. Many outside engineers—some with expe knowledge and some without—gave their opinion s to the wisdom of constructing a concrete conduit, d it was said that under the conditions existing, conc te was a very unsuitable material for such a work. thers—notably Mr. C. E. Deakin, the contractor—wer of opinion that the conduit was built as well as p ible, and that the work on the aqueduct, which had en blamed for the break, would not, from a mathema l point of view, be considered as endangering the nduit in the least. The breakage was a pure accide r which no one could be held responsible.

The cause of the brea the time of writing, had not been definitely ascert but it was held by many as being due to work on nlargement of the aqueduct. It was supposed he excavating machine encroached too closely u e conduit and removed the supporting earth, wit result of a bad break.

At a meeting of lead izens it was decided to secure the services of the vater engineer available on the continent with a to an independent enquiry. The Controllers so promised to conduct a thorough investigation. It will be interesting to record the findings in due course.

The Engineer and the Accountant

IN the administration of large manufacturing plants and public-service corporations the combined abilities of specialists in engineering, law, production, salesmanship and accounting are essential to an efficient conduct of affairs, comments The Engineering Record. Between the first and the last-named class of experts a wide gap formerly existed, but the broadening tasks of each have brought the engineer and the accountant into closer relations, notably in connection with the work of commission regulation, the study of operating economies and the more extensive tabulation of construction costs. Around the conference table of the efficiency committee the accountant and the engineer come into especially effective contact.

A few specific illustrations of the sort of co-operation that is needful may be given. In practically all cases where a company appears before a State board seeking permission to issue securities it is required to present a list of the expenditures which it is proposed to capitalize, and usually at the stock or bond hearing following the petition a long exposition of these expenditures occurs. Often the lists are inadequate as to detail, and insufficient data are given to enable the commission to compare the actual or anticipated costs with similar expenditures elsewhere. It is most important that all legitimate costs shall be included in such exhibits, and here the accountant's broad knowledge of classifications and the segregation of items, combined with the engineer's understanding of what is essential in the way of physical data, may be of the utmost value. Unless an engineer has had a good deal of experience in court and commission work he is liable to overlook features of expense which the accounting expert will set forth at the outset. On the other hand, if the data are left for the accountant to compile he is almost sure to overlook some fundamental engineering dimension or quantity, without which no intelligent opinion can be rendered as to the propriety of the expenditure. In an extreme case it may lead to a scaling down of the amount permitted to be capitalized, which means that the burden must be borne out of immediate earnings by reduction of a hard-won surplus, or by slicing the depreciation allowance. The only safe way is for both engineer and accountant to go over exhibits of this character with the greatest care before delivering them to the executive or legal advisers conducting the company's case.

In valuation work the accountant needs the assistance of the engineer in the interpretation of items of plant expenditure, in the analysis of construction costs, and in the treatment of depreciation. The engineer's opinion as to the life of equipment and its fitness for service after a stated period must largely guide the accountant in his consideration of replacement costs, and the former obviously is the best interpreter in an operating organization of maintenance expenses. No accountant without engineering training or advice is in a position to judge whether repair costs are normal or abnormal in relation to the service conditions. The engineer, for his part, needs the comprehensive viewpoint of the student of figures in making sure that his subordinates keep adequate records and properly classify accounts so that unusual conditions can be noted with the least possible delay. In the working out of cost systems these two classes of experts should confer at sufficient length to yield results of interest to the technical man no less than to the bookkeeper. Engineering advice may be as useful in the accounting department as in the purchasing bureau, and the recommendations of the accountant ought to make the work of the engineer easier if the classification adopted in a given company is the joint product of their labor.

It is surprising how difficult it is to maintain an accounting system which will give at short notice the variety of engineering or operating data which may be demanded in a special investigation, such as an analysis of wages and hours of service on a railroad; but this is a result of the expense of multiplying statistics which are really by-products of a company's bookkeeping records. There seems to be no limit to the amount of analytical study that can be applied to a payroll of this kind. In the arbitration of the hours and wages of street-railway employees now drawing to a conclusion at Boston, one of the most remarkable features of the inquiry has been the amount of extra work required from the auditing department of the Boston Elevated Company in the preparation of special information from its routine records to enable the cost and duration of platform labor to be thoroughly analyzed. The company's accounting system is exhaustive and scientific; but it is obvious that all the combinations of data which may be of possible engineering or operating use after being derived from such records cannot as a practical matter be maintained from month to month without undue expense. On such a system close relations between its engineering and accounting staff constantly tend toward the production of records of real value in the solution of special problems and toward the economy of time in studying the operation of the road from special angles of inquiry. In defining just what sort of statistical data are desirable for executive deductions there is a field for larger mutual service for the engineer and the accountant than has often been developed in the past.

One of the noticeable features of the large and more elaborate building undertakings of recent date is the increased use of terra cotta trim. Between terra cotta trim and the fancy finished brick and stone, other material formerly used extensively in face work is being crowded aside considerably. Sometimes an entire face is made of the terra cotta and at other times fancy face brick is used. It is terra cotta trim which breaks the monotony and puts in the trimming effects which harmonize beautifully with the other clay products. Terra cotta and face brick make an ideal combination in buildings big and little, and architects seem very favorably inclined toward terra cotta trim. This means that it is not only gaining ground but also that conditions are ripe for more extensive development in its use.

It is reported that the harbor of Dover, Eng., is practically derelict. The results of an extensive survey show a tremendous waste of public money. Although the harbor was completed only four years ago at a cost of £4,000,000, heavy silting, which experts attribute to the faulty construction of the entrances, necessitates an annual expenditure of £70,000. The result is that, although the harbor was built as a naval refuge, naval vessels rarely enter.

Engineering Topics In The Old Land

London Correspondent of The Contract Record Discusses the Proposal to Form a Canadian Institution of Municipal Engineers—The Need for a Central Authority to Control Municipal Borrowings in Canada—Civic Excursions

Special Correspondence of The Contract Record

London, December 23, 1913.

VERY considerable interest attaches here, in England, to the formation of the Canadian Institution of Municipal Engineers. Opinions are divided as to the desirability of affiliation to one of the English societies, and even if affiliation were deemed the politic course a further difficulty would arise. The profession of municipal engineering is represented in England by two bodies: The Institution of Municipal and County Engineers, with a life of some forty years, and the Institution of Municipal Engineers with a life of a little over five years. Six years ago the former body was lying moribund of sloth and inanition. Its rules, its methods of procedure, its administration, were obsolete. It was controlled by quite a small section of its members and no outsider could hope for admittance within the charmed circle unless he undertook to fight innovation and progress to the last ditch. The membership class was limited to those who held chief appointments, and there existed the anomaly that while the deputy engineer of a city such as Manchester, Liverpool, or Birmingham was ineligible for the class, the "chief" of the smallest district council—who might combine the offices of surveyor, sanitary inspector, petroleum inspector, rate collector and clerk, all for some £70 a year—was admitted without demur. The formation of the Institution of Municipal Engineers has changed all that, for the younger body is nothing if not progressive. It quickly realized the anomaly referred to, and it went further, for it recognized that gas, water, and electrical engineers to municipal authorities were municipal engineers equally with the men who controlled simply the highways and bridges, and sewerage and sewage works of the country. So as fast as the younger body progressed, introduced new methods, abolished anachronisms, and modifying obsolete procedure, so fast did the older body follow in its footsteps, accepting all and giving nothing, but none the less setting its house in order and taking on a new lease of life. That is precisely how matters now stand, the newer body constantly progressing, and the older body being as constantly forced by its members—by outside pressure, that is, for the circle still tenaciously cling to tradition—to adopt any and every measure. It has to be remembered, however—and the point is an important one—that the older body scores largely as regards prestige, while its roll contains the names of the greater proportion of the engineers to large cities and towns. Defections from its ranks have taken place among the smaller fry alone; but again, it must be remembered that the small chief or the deputy of today will be the big man of to-morrow, and the next few years will see a considerable levelling upwards in this respect. The Canadian Institution will do well carefully to weigh matters up before affiliating with either one body or the other; indeed it remains open to grave doubt whether affiliation would not be a most unwise proceeding. In any event, it would surely be wrong to take any such step until independent working had been tried. The English societies would necessarily be in friendly touch with the Canadian, and such little courtesies as exchange of proceedings and the extension of facilities to visit works (when members contemplated crossing the pond) would not be wanting.

Regulations of the Proposed Institution

It is customary, in drawing up the rules and regulations which are to govern a new society, first to obtain copies of those of existing societies of a similar nature. These are then submitted to the process known as "boiling down," the result of which has been exemplified by scores of instances. Experience has taught us that the happier the country the fewer its laws; hence the extreme anarchist (or no law) ideal. The really necessary by-laws for a professional society could be written on one side of a sheet of foolscap paper, whereas there is scarcely a body in existence that is regulated by less than some twenty printed pages. Is it too much to hope that the Canadian Institution will make its own regulations, and that it will in their making aim at brevity and clearness? The question of whom to admit and whom to exclude is always a difficult one in the case of a professional society, and the solution is to be found only in the admittance of all. Thus, in a municipal engineering society, all who are municipal engineers (in any capacity) and all who are in training for such a calling—whether as premium pupils or not—should be admitted, regardless of age, colour, or nationality. Such a society is only too often of the mutual admiration order, and a few top dogs rule the roost. Admit the rank and file, on equal terms if possible, and such a condition of things becomes impossible. The Institution of Municipal Engineers started with one class only—it has now three, and is proposing a fourth, and to that capitulation to the attacks of snobbery and dignity may be traced the slowness of its numerical progress during the past three years. A third point of no little importance is the position of the consulting engineer as an applicant for membership. A consulting engineer is not a municipal engineer in any sense of the word, even though he may call himself a consulting municipal engineer or some such hybrid name. He is out for business as much as is a manufacturer or contractor, and if the members of the last-named classes are ineligible for election there seems no reason why those of the other should be admitted. As a member of an institution composed of civil, mechanical or electrical engineers, the consultant has nothing much to gain. It is useless for him to canvass his fellows, for they are all out for work themselves. Turn him loose however among municipal engineers and his course is clear. He will utilise his membership for business purposes, and such being the case it might be argued that he should be refused admittance. But then, he is a very useful man, of considerable experience and free to speak his mind as he thinks fit, and so long as he keeps within decent bounds there is no reason why, on the other hand, his application should not receive full consideration. Men styling themselves consulting municipal engineers should be sternly taboo, however, and the writer may be trusted to have good and valid reasons for such a strong pronouncement.

A Canadian "L. G. B."

The suggestion has been made that some central authority, like the English Local Government Board, should be formed in Canada, in order that "municipal borrowings could be sifted for the satisfaction of lenders." It is argued that some such authority, which would control municipal borrowings and supply information concerning securities offered, is much needed; indeed that some such organisation is essential to the maintenance of high municipal credit. It is felt here, in England, that the adoption of the suggestion could work only for good, and would do much to strengthen the advances made to the Canadian municipalities. The exercise of borrowing powers in England is regulated by the Public Health Act, 1875, and the regulations for the guidance of the Board are of a stringency which might not meet with favor in Canada. Too, the personnel of the Board here leaves much to be desired. As regards the first point, the following extracts from Section 234 of the Act will be of interest.,

> (1) Money shall not be borrowed except for permanent works (including under this expression any works of which the cost ought in the opinion of the Local Government Board to be spread over a term of years):
>
> (2) The sum borrowed shall not at any time exceed, with the balances of all the outstanding loans contracted by the local authority under the Sanitary Acts and this Act, in the whole the assessable value for two years of the premises assessable within the district in respect of which such money may be borrowed:
>
> (3) Where the sum proposed to be borrowed with such balances (if any) would exceed the assessable value for one year of such premises, the Local Government Board shall not give their sanction to such loan until one of their inspectors has held a local inquiry and reported to the said Board.

As to the personnel of the Board, this is composed almost entirely of ex-army engineer officers, whose knowledge of the requirements of a town is only too often of the vaguest. Military men are seldom a success in civilian affairs, and an officer whose life has been spent in, say, the construction of bridges in India is scarcely the man to serve as a final court of appeal in a town's requirements. There has been one notable exception in these appointments, but that official—an experienced municipal engineer—is now superannuated and none has taken his place. If Canada decides to appoint a board of her own, she would be well advised to be chary of introducing the military element. An engineering inspectorship is no sinecure, and only the best and most experienced men should hold a position of such national importance. A staff of men who are at least open to the suspicion of having failed at their own legitimate calling—else why the necessity for their retirement for civic offices?—cannot but prove a clog upon municipal enterprise, as the English municipalities have found to their sorrow on scores of occasions.

Civic Excursions

The City Board of Trade of Medicine Hat, Alberta, is wise in its generation. "Medicine Hat Day" should be a great event, and London and other great English cities might do well to follow the example set. The writer records with shame the fact that however well he may "know his London," topographically and socially, his knowledge of its "sights" is regrettably limited. Passing Westminster Abbey daily, he has not entered it since he was a boy in socks and bare legs. Passing the Houses of Parliament daily, he has never entered them at all! The Tower of London is a forgotten memory, and his last visit to St. Paul's Cathedral was for the purpose of sheltering from a shower of rain! The idea of "an excursion of citizens to view their own city" is a great one, and especially perhaps as regards the industrial side, for it is true that "many people, even business men, do not realise the importance of industrial development." Visits innumerable are paid by London school children to the great sights, but with the closing of the school gates behind them interest seems to cease. The industrial and manufacturing centres are neglected in toto, at all ages and by all classes. Perhaps London may be fired by the example set by Medicine Hat. That she could gain much by so doing is beyond dispute.

Water-Tightness of Untreated Concrete

Experiments on the water-tightness of plain, untreated concrete are being carried on in great detail at the College of Engineering of the University of Wisconsin. The series is not completed but it is stated that those tests which have been made show that good results are obtained if the concrete remains in the mixer from two to three minutes when dry materials are employed, but that for cases where the sand and gravel or stone are damp a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. The experiments showed that mixtures consisting of 1 part of cement, 1½ parts of Janesville sand of the torpedo grade, and 3 parts of Janesville gravel, when mixed to a wet consistency, are impervious to water when subjected to a pressure of 40 lb. per sq. in. Mixtures as lean as 1 part of cement to 6 parts of gravel (a graded mixture) have been made impervious at high pressures by using care in proportioning the amount of water and in mixing the batch. The specimens used in making these tests are cylindrical in form and so made that the faces of the cylinders, which are 13½ inches in diameter, are exposed to the predetermined water pressure. The thickness of the concrete through which the water must pass can be varied from 4 to 18 inches. Ample provision is made for cleaning both faces of the cylinder before placing it upon the testing apparatus. The department is also studying the effect of varying the percentage of cement and water, the gradation of the sand and gravel, the proportioning of the mixture, the thoroughness of mixing, on the hardening of the specimens.

A suggestion for an innovation in civic construction work has been made to the Winnipeg Board of Control by W. G. Douglas. He believes that by manufacturing cement curbing for street paving at the city shops during the winter months much time could be saved when construction work starts next spring. Experts have declared the scheme to be quite feasible, and the controllers favor it on the ground that it would give a good deal of work during the winter months to men who would otherwise be out of employment. It is even believed that the curb could be made at the shops quite as cheaply as on the streets.

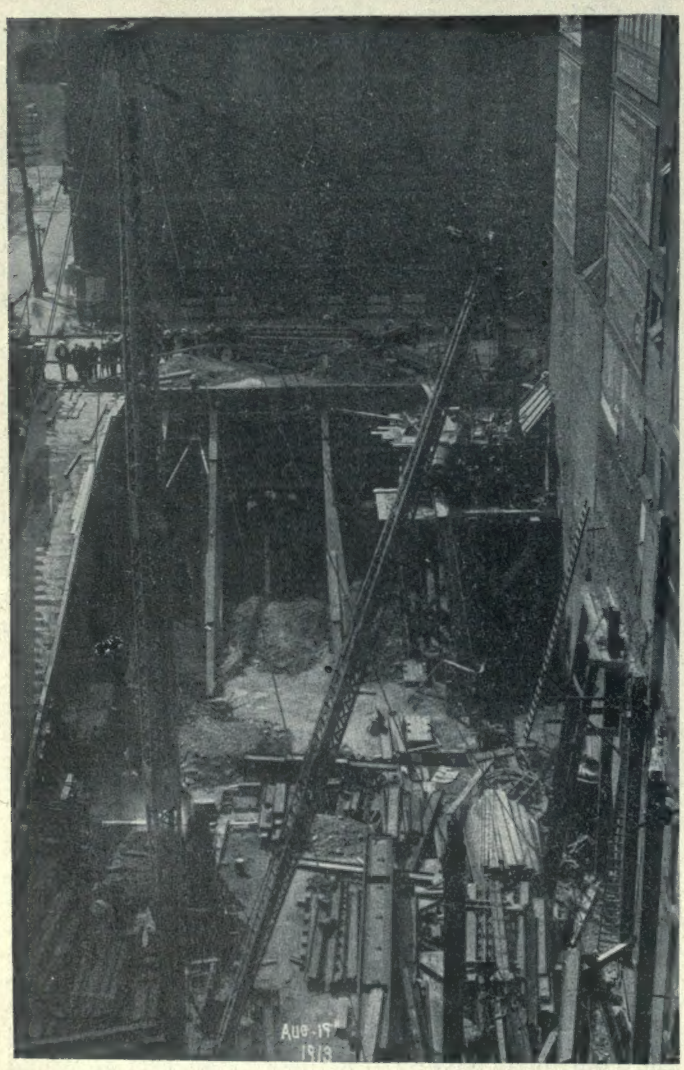
Constructional Features of the New Dominion Bank, Toronto

Progress Article

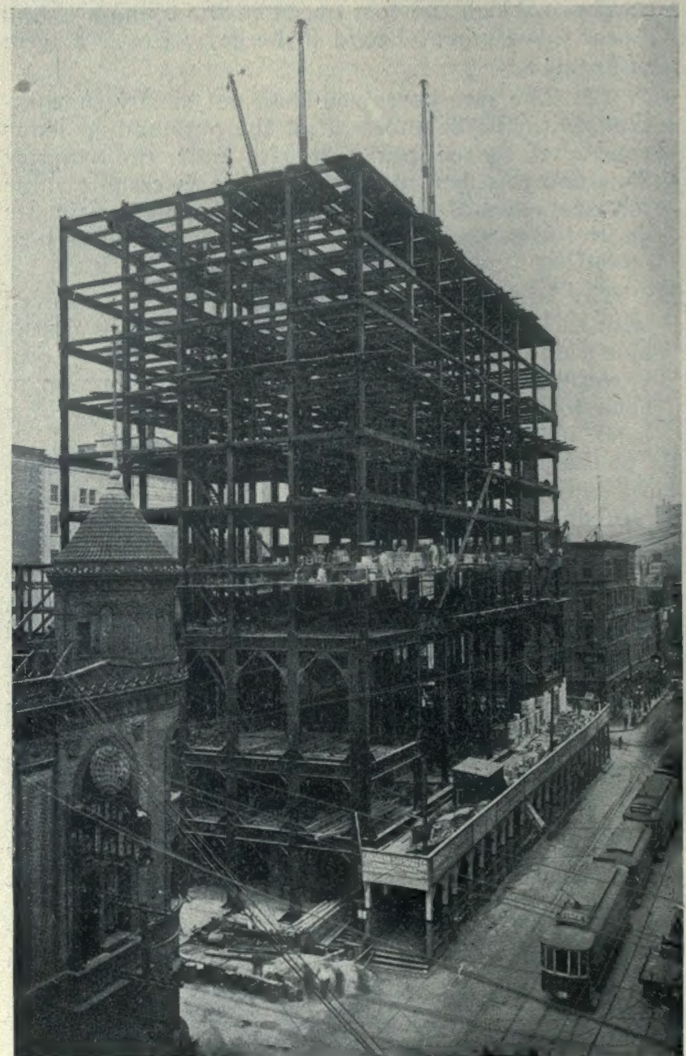
IN the construction of the Dominion Bank building, Toronto has a new record for the rapid erection of structures of this type, and, what is more, it has a building which in point of design and structural finish sets a new standard of attainment for the expenditure involved.

The site upon which the building stands, at the corner of Yonge and King streets, may be said to be the hub of Toronto's commercial activity, and the new structure will prove a worthy headquarters of the progressive interests responsible for its erection. With a frontage of 168 feet on Yonge street and 75 feet on King and Melinda streets, the building consists of twelve floors and roof rising to a total height of 186 feet, it being ten storeys above grade. Although it is several floors less than the headquarters of the Canadian Pacific Railway on the opposite corner, which is claimed to be the highest office building in the British Empire, there is only a difference of about fifty feet in the two structures.

The building, which has a sub-basement and basement, is of granite to a height of about fifty feet and of terra cotta above. The style of architecture is a free adaptation of the Italian Renaissance. The structure is of skeleton steel construction with tile arches and is done in fireproofing throughout. The sub-basement was excavated to a depth of 38 feet below the street level and solid rock was encountered at practically the position of the grillage beams. These beams were delivered in July as fast as excavation permitted and the first columns were erected on August 19. Included in the sub-basement, mezzanine floor and roof, there are fourteen tiers of beams and girders supported by fifty-nine columns. Some idea of the dimensions of the building may be gathered from the fact that in the erection of the bank about 2,300 tons of steel were used.



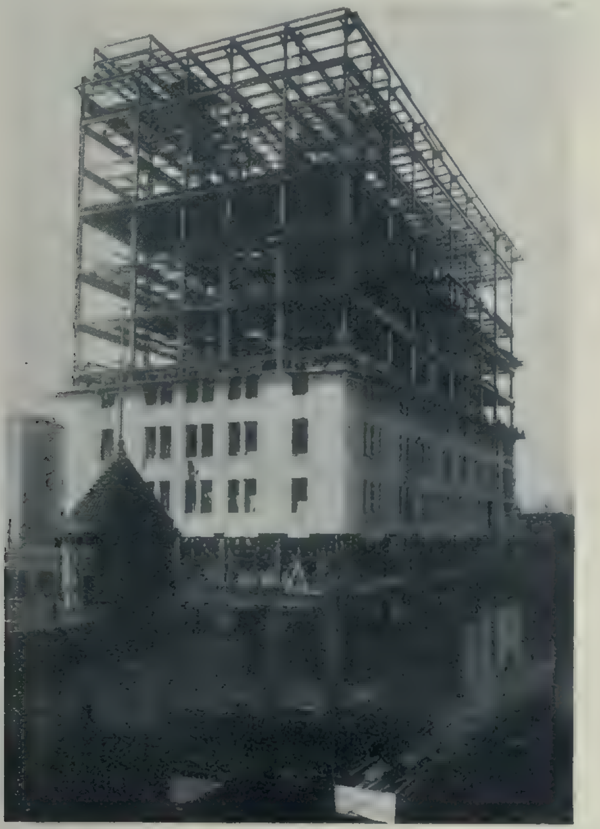
First column of steel work in course of erection (August 19). One of the derricks is seen in position in the basement. Part of the work under way in excavation for the grillage beams and the Melinda street end of the building.



From the above illustration it will be seen that the steel work has been completed to the tenth floor and is ready to receive the last tier of columns. The commencement of the stonework on the fourth floor (Oct. 21) is also shown.

The steel for this structure was put together in just sixty-four working days—the final erection of the roof beams being completed on October 31 and the rivetting and painting of the entire steel work finished on November 10. This is an achievement of note. The steel contractors state that had it not been for occasional delays in transportation of material their portion of the work could have been completed in still less time.

Among the illustrations in this article is one showing the foundation as it appeared on August 19 and another the completed steel skeleton construction and a large portion of the granite work in position on Nevember 10. Up to the top of the second or banking floor the steel work was fabricated from stock at the Toronto plant of the steel contractors, while above the second floor it was of "Bethlehem" construction for the columns with "Carnegie" beams specially rolled for floors. For the work of erection two steel guyed derricks with eighty-foot masts and seventy-three booms were utilized, the derricks being raised two floors at a time as the building progressed.

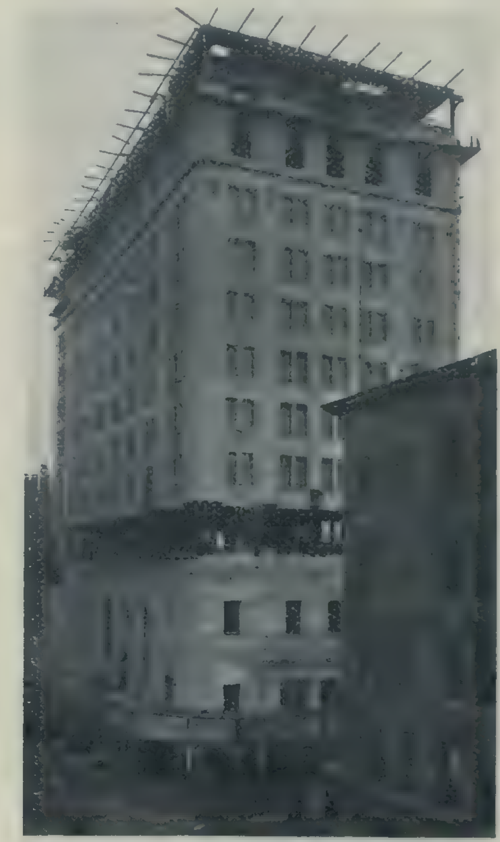


This photo shows the wind-bracing connecting the beams and columns, and the starting of the walls at the second floor The last beams have been placed in position and the derricks removed from the top (October 31).

The granite Doric columns at the entrance are three feet in diameter and twenty-five feet in height. Extending to the Mezzanine floor, the columns are an ornamental feature which will add greatly to the general attractiveness of the picturesque granite front. The detail of the three facades of the building is simple but at the same time very attractive. Architectural terra cotta has been used in the entire exterior of the building above the granite work, in all about 800 tons of the material having been utilized. The floor arches between the beams are of terra cotta fireproofing construction. The terra cotta is a light grey color, speckled and matt glazed, the ornamental features consisting of shields set very attractively on all three elevations of the bank. Circular columns beginning on the ninth floor and artistic railwork running right around the building are also attractive features. It is the intention to erect further ornamental work above the roof, next spring, by which time the building will have approached completion.

Interior Features

The interior of the building promises to excel most other buildings in the city regarding equipment and finish. The ground floor will be occupied by the Savings Bank department. Immediately above it is the main banking room floor, which will be approached by a monumental staircase of marble, fitted with bronze balustrade. The main banking-room as well as the savings department will be lined with marble from floor to ceiling. The particular kind of material to be utilized for this purpose has not yet been decided upon. The ceilings of both banking-rooms will be of ornamental plaster and the counters lined with marble, with grilles erected for a certain distance above them as is the custom in banking offices. The floors of both banking-rooms will be laid in marble tiles. From the second to the seventh inclusive the floors are divided for office accommodation and will be sub-divided to suit tenants. On the eighth floor there will be dining-rooms and kitchen for the use of the banking staff.



Entire steel work finished and nearly all granite in position (November 10). Stonework incomplete at third floor to facilitate handling of material and protect exterior ornamental work.

The ninth floor will be the Head Office of the Dominion Bank. It is twenty-two feet in height, lighted from the centre by ceiling light and surrounded by a mezzanine floor. Needless to say this section of the building will be in every respect worthy of the purpose for which it is intended. Lavatories for the head office staff will be located in the attic, as also the janitors' quarters.

The building is equipped with six passenger elevators of the Otis-Fensom type and there will also be five lifts descending to the vaults. A complete system of air-washed artificial ventilation will be installed, while the building will be steam-heated throughout. All the elevators will run to the basement which contains the safety deposit vault which is reached from the savings department. All the elevator hall walls will be lined with marble. The elevator grilles on the ground and main floors will be of bronze, those on the upper floors being of wrought iron. Lavatories for the banking-room staff will be located in the basement and others will also be provided on every office floor. The heating plant, boiler and machinery room are located in the sub-basement.

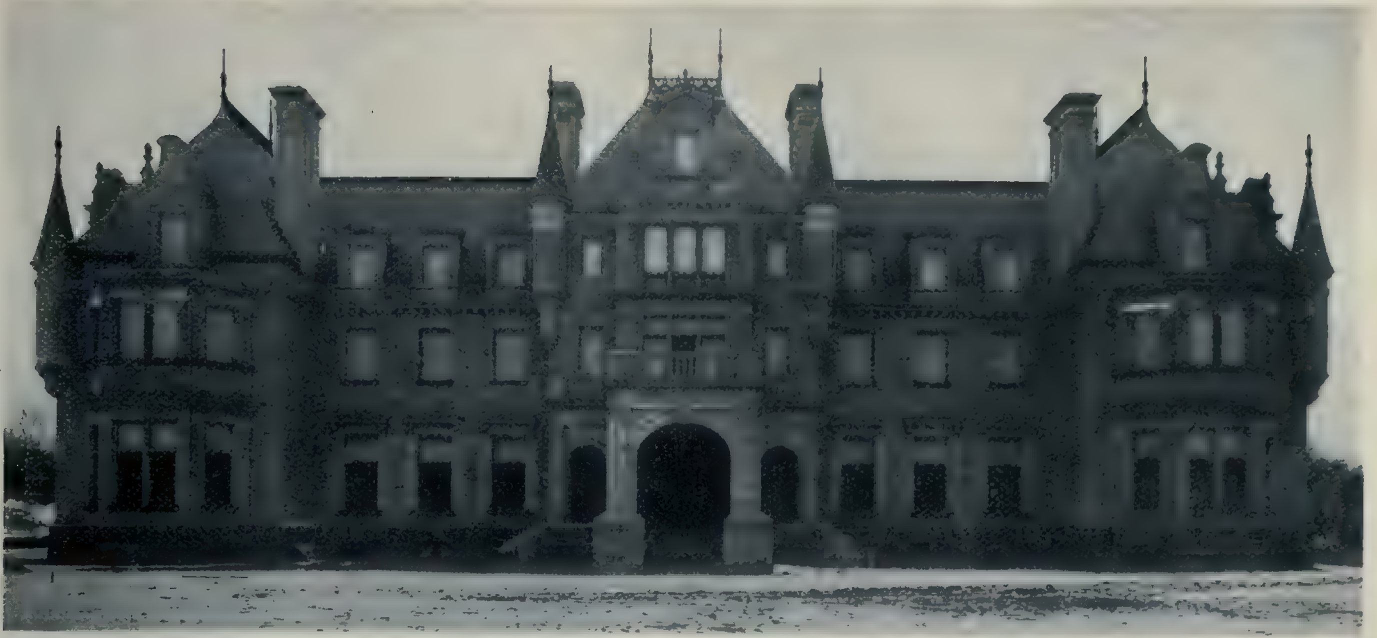
When completed the building will have involved an outlay of about one million dollars and it is expected that it will be ready for occupation before the end of 1914.

Dominion Bank, Toronto—Exterior work practically completed (November 30)

The building was designed by Messrs. Darling & Pearson, architects, Toronto, with Messrs. Harkness & Oxley as consulting engineers. The general contractors are the Canadian Stewart Company, Limited, the work being under the supervision of Mr. G. Griest, manager of the Toronto office. The entire steel work was supplied and erected by the Canadian Allis-Chalmers Company, Limited, Toronto, the shopwork and erection being under the immediate supervision of Mr. J. L. Brower, manager of the bridge department of the company. The granite was supplied to the order of the general contractors by the McIntosh, Beebe Granite Quarries, Quebec. The Northwestern Terra Cotta Company (for whom the Black Building Company are the Toronto agents) had the contract for the architectural terra cotta. The fireproofing was supplied by the National Fireproofing Company. The high-grade face brick was furnished by the Kittanning Brick Company, whose Toronto representatives are Messrs. Scott, Hammond & Pratt, Limited. The Don Valley Brick Works, Toronto, supplied the hollow brick and the Port Credit Brick Company the common brick. The boilers, etc., were furnished by the John Inglis Company, Toronto. The ornamental iron work was supplied by the Architectural Bronze and Iron Works, Toronto.

Designing for the Future

To point out the danger of determining types of structures or processes years before they are built is not common. But not infrequently portions of work—foundations, for example—are put in when the primary installation is made, leaving the completion of the work until such time as increased capacity is required. In some lines advancement is so rapid that installations only a few years removed from each other in date of construction are radically different in type. The later installation is naturally the more efficient, and when the increase in efficiency is very marked it is sometimes advisable to scrap the earlier equipment, no matter what its remaining life. While these are elementary considerations, recent occurrences give them point. Advances in hydro-electric practice have been so rapid that even before the great Keokuk plant was put in operation certain features of the equipment had become obsolete. More recently it has been rumored that in a large installation where foundations were prepared for double-runner wheels, single wheels will be used instead. The moral is that in building any portion of a future structure, whether in hydraulic or other branches of engineering, the work should not be carried beyond the simplest stages. Just how far it is advisable to go must depend entirely upon the judgment of the engineer in charge and his knowledge of the history of the art. In some lines there is a fair degree of certainty that the general types now in use will be adhered to for some time, while in other branches practice is in such a state of flux that there is possibility that even the most simple foundation work will need to be destroyed when additions are necessary. This factor has risen in connection with the design of the terminals for the New York State Barge Canal. It was concluded that nothing but the docks should be constructed at the present time, leaving the design of superstructure for a later date, so that it may be made to conform to whatever type of handling device is proved to be most economical by the time the terminals are to be put in operation. Again, in the papers on the Imhoff tank published in this journal recently the same idea was emphasized. The advances in sewage disposal are so rapid that the construction of tanks which are not needed for four years or so is hazardous. The point is well worth bearing in mind when conditions dictate the advisability of putting in some portions of a structure not needed at the present time. There is danger of forcing the use of equipment or processes which will be obsolete a few years hence, or of losing large sums in discarding or removing the partly constructed work to make way for the more efficient methods.—Engineering Record.



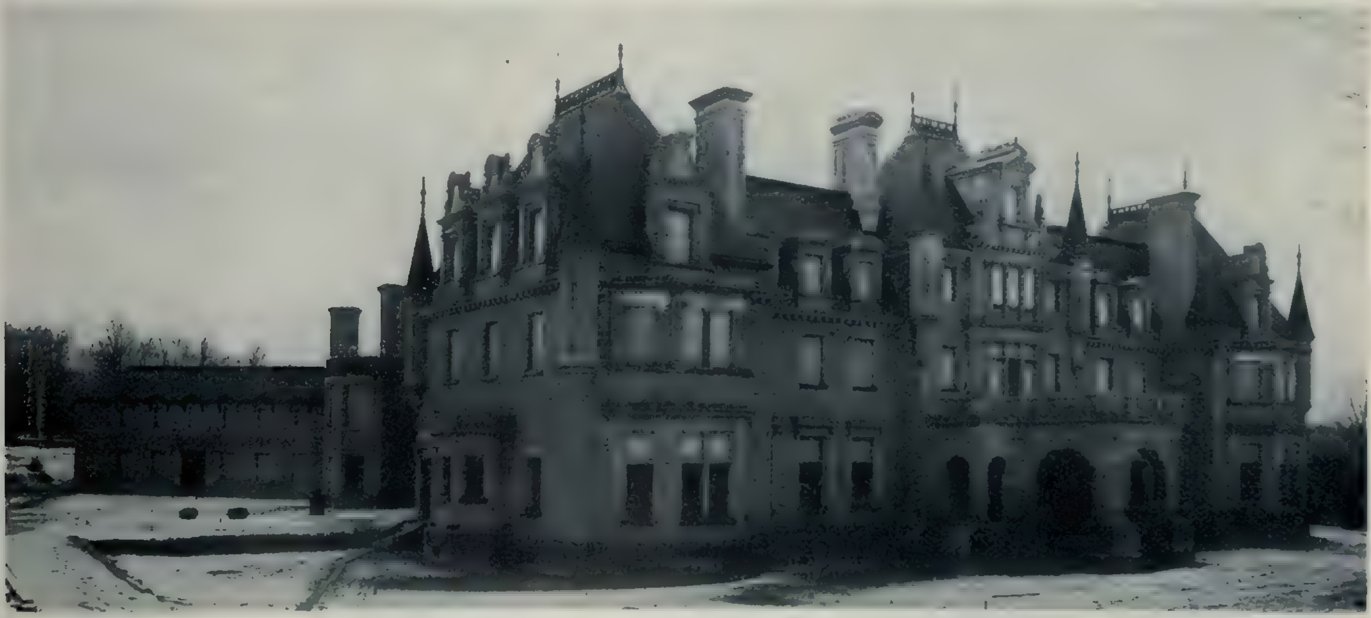
New Residence For the Lieutenant-Governor of Ontario

The above is a front view of the attractive residence now being completed for the Lieutenant-Governor of Ontario. In point of design and construction the building possesses a number of features of outstanding interest, but although this is a public edifice, built with public funds, the most unreasonable reticence has been shown by the government officials, with the result that the accompanying pictures and details, meagre as they are, constitute practically the first authoritative article on the work published.—Editor.

CONSTRUCTIONAL operations on the official residence for the Lieutenant-Governor of Ontario have reached that stage when a description of the main features is timely. Located in one of the most inviting suburbs of Toronto, Chorley Park, and being within easy access of the city, the official home of the Lieutenant-Governor will rank second to none in point of architectural gracefulness and beauty of general setting. The photographs reproduced herewith afford an idea of the building as it now appears, the main as well as the side entrance being shown to advantage. The house is in the French Chateau style of architecture and is faced with grey Credit Valley coursing with cut stone trimmings of grey sandstone.

The interior is fireproofed with porous terra cotta, consisting of cambered arching for the floors and terra cotta partition walls. All the beams and columns are protected with terra cotta, the entire roof being covered with "book tiles."

There are nineteen rooms in the basement, twenty-four on the first floor, twenty-four on the second floor, and twelve on the third floor. The total number of bedrooms situated on the two latter floors is thirty-six. A bathroom is connected to each. Of the rooms in the basement and on the first floor the secretary's



Lieutenant-Governor's residence, Toronto. View from southwest.

and waiting rooms, the Lieutenant-Governor's office, the state and private dining rooms, the kitchen and servants' rooms, are on the west side. On the east side are the reception room, drawing room, writing room, living room and palm room. The rooms on the first floor are sixteen feet high from floor to ceiling, with the exception of the ballroom which is 25 feet 6 inches from floor to laves. The porte cochere is of cut stone. There are terrace bays to the living room on the east and to the state dining room on the west. The palm room is of cut stone on three sides and overlooks the Don Valley on the east. On the east side of the ballroom there is an alcove, thirty-two feet by twelve feet, with a casement opening on to the verandah. The latter is of cut stone with massive stone columns and monoliths, the columns in one stone each weighing three tons. The ballroom has an apsidal end to the north and the billiard room situated on the second floor over the dining room faces towards the west. The residence is expected to be ready for occupation in 1915.

The contractors who have been working on the building up to the present are:—Messrs. F. Holmes & Sons, cut stone, brickwork and fireproofing; Messrs. Douglas Bros., roofing; Messrs. Canada Foundry Company, Limited, steel; Messrs. Purdy, Mansell, Limited, plumbing.

Explosives and Their Use in Excavation Work for Buildings

By C. E. Anderson, New York City

Of the difficulties encountered in building and construction work, perhaps the most difficult and at the same time least understood operation is the removal of rock from a building site. Such work is often let to some sub-contractor or is handled in the best way known to the contractor, which in many cases turns out to be a very expensive operation. The blasting of rock is a science which can be learned only by experience; but even experience does not teach everything about the subject, and most contractors must gain a knowledge of this subject without seeing work done by the best powder men. The following article considers some of the essential points relative to work of this kind, and also gives some of the characteristics of explosives.

Explosives and Their Characteristics

Explosives may be divided in a general way into two classes: low explosives, such a gun-powder; and high explosives, commonly known as dynamite and sold for different purposes under various names such as gelignite, gelatine dynamite, giant powder, forcite, etc. Gunpowder is composed of siter, sulphur and charcoal. Dynamite is made in a number of different strengths; that known as 40 per cent. dynamite is the most commonly used and is comparatively safe to handle. It is composed of nitroglycerin, or some similar compound, mixed with other compounds and wood-pulp. Great care must be exercised in using gunpowder, and no light should be brought near it, as the dust raised in loading a hole will sometimes communicate flame to the powder. The writer has seen men burned out of all recognition through carelessness in this respect. Dynamite may be used with comparative safety if it is carefully and sensibly handled.

In handling dynamite certain precautions must be taken, and some of its characteristics, which are not always understood, will be mentioned. Nitroglycerin freezes at a temperature ranging from 42 to 46 deg. F. Dynamite is more sensitive to friction when frozen, and the cutting or scratching of frozen dynamite is likely to result in a serious accident. Moreover, it can not be properly detonated when frozen and must be thawed before being used. Too much heat or moisture is also injurious to dynamite, causing it to "leak." It may soak into one end or one side of the cartridge, where it becomes highly concentrated, or it may even soak into the box. The writer has heard of empty dynamite boxes exploding when burned, having absorbed some of the nitroglycerin. Dynamite which is in this condition can be detected because of the "soggy" feeling of one end or one side of the cartridge. Such dynamite should be carefully handled, as it is much more sensitive to shock than if in good condition. Frozen dynamite should be carefully thawed. Dynamite which has "leaked" should be destroyed by burning in a safe place, setting the sticks end to end before lighting. Cartridges should never be thawed by steam or hot water, as the water will tend to replace the nitroglycerin. Thawing by placing near a fire is also dangerous. The safest method is to place it in a box beneath a pile of green manure or spread it out in a warm room. After thawing, the cartridges are likely to leak, and should be carefully examined before using.

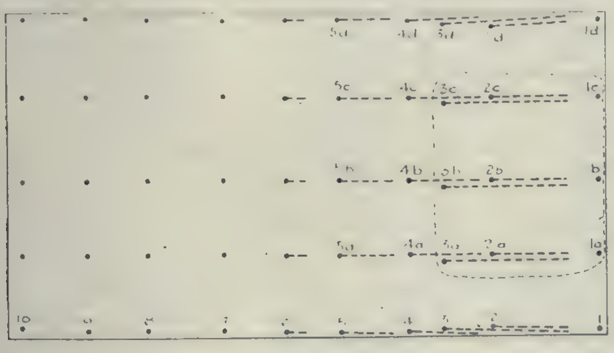
Use of Explosives in Basement Excavation

The plan and section in Fig. 1 show a good method of drilling the holes for removing rock from a basement excavation. In Fig. 1 (a) the holes are shown by heavy broken lines and the depth and limit of the excavation are shown by the light broken lines.

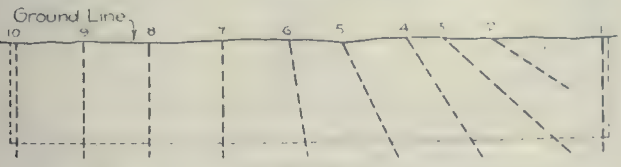
In blasting soft rock or shale it is customary to use powder in preference to high explosives, since it is slower in its action. If dynamite is used in soft rock it usually blows out a small crater-shaped hole, for the reason that the action is too rapid to communicate itself to the surrounding rock. On the other hand, if powder is used the action is slower, the force exerted will be communicated to the surrounding mass, and more rock will be loosened. If the rock is hard it is better to use dynamite, as it is necessary to shatter it with a sudden shock.

Powder can be used to advantage in quarrying stone which is to be used in masonry work. In this case a line of wedges is driven, together with a few bore holes at regular intervals, along the line where it is desired to split the rock. After the wedges have been driven in solid, a few light blasts with black powder will split the rock along the desired line.

It is seen from Fig. 1 that holes Nos. 1, 2 and 3 form a triangular or wedge-shaped section. If these three holes are fired at the same time they will start the excavation by blowing out this wedge-shaped piece. It would be better in starting to first blow holes Nos. 1a, 2a and 3a, or if an electric blasting machine is used the three center groups could be "pulled" at the same shot. This would loosen the material shown inside the curved dotted line on the plan. After the loosened rock had been removed the rock at the sides could be blasted from the two groups of holes Nos. 1, 2 and 3, and Nos. 1d, 2d and 3d, which now could be fired without danger of breaking back outside of the excavation line. The remaining holes could then be fired in groups; the number fired at each shot depending upon the method of firing and upon other conditions. It is best in each case to pull the center holes first, leaving sufficient space to shoot the side holes. The spacing of holes is largely a matter of judgment; in general, the distance from the hole to the fact of the rock which is to be blasted should be about three-quarters of the depth of the hole. In deeper holes the "burden" would be less in proportion to the depth of the hole. Figure 2 shows the manner in which the rock breaks under a high explosive and indicates the proper depth of hole. The distance W, which represents the burden, is three-quarters of the distance from the center of the charge to the top of the hole. The hole shown in Fig. 2 represents a "sprung" hole, the charge being entirely in the "sprung" or enlarged portion of the hole. If the face cd of the rock is free, as indicated by the drawing, the shot will break out a crater-shaped section, indicated by the lines ad and ef, carrying with it the shoulder above. If, however, the hole is merely drilled to the floor of the excavation, represented by ab, the force of the blast will be reflected upward from the floor and will break out a section included between the lines eg and ak, which will also carry with it the shoulder above. This explains why the rock will fly more if the hole is loaded too high. If the hole is not sprung, and is loaded up to the point h, the rock will break as indicated by the line hi. It is evident that the distance from h to the top of the hole does not leave enough rock on top of the blast to resist both the direct force of the blast and the force reflected from the floor. Thus the portion hij is broken by the direct strength of the blast and is then met by the upward rebound, and the broken pieces are thrown into the air. Figure 3 indicates the action when the hole is drilled too deep, and explains why in some cases it is so often necessary to "mudcap" or "dobe" large pieces on some work. If the hole is drilled too deep the charge blows out a crater-shaped section of rock at the bottom of the hole, and the shoulder above this crater is broken off or is left hanging without being shattered. It is then necessary to mudcap the big pieces in order to make them small enough to handle. By mudcapping is meant the placing of several sticks of dynamite on top of the boulder which is to be broken, covering them with mud or clay and firing them. In the west, this is called a "dobe" shot. A shot of this kind is occasionally necessary, but if it occurs too often the depth of the hole should be changed in proportion to the size of the burden.



(a) Plan



(b) Section

Fig. 1.—Plan and section showing method of placing holes for excavating rock from building site.

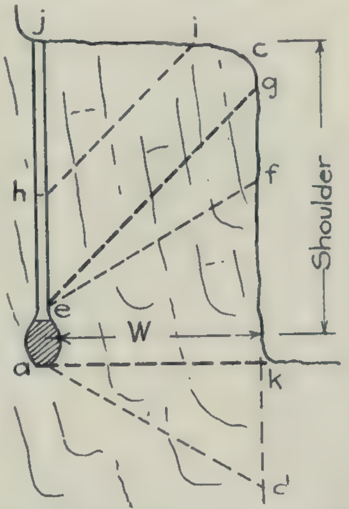


Fig. 2—Lines along which rock will break with proper depth of hole.

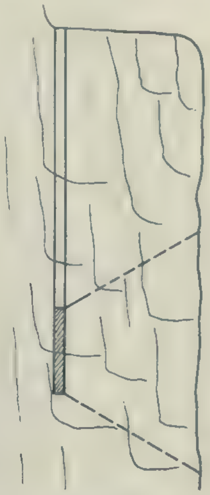


Fig. 3—Action of a high explosive in a deep hole.

Kinds of Drills.—Figure 4 indicates the best shape for drill bits. The hand drill is forged crescent-shaped and is tempered to a "grey temper." The drawing also shows a machine drill bit and indicates the right and wrong way to sharpen a drill bit. If incorrectly sharpened, the cutting edge wears down faster than the shoulder, and the drill will stick in the hole. If a shoulder is left on the drill it should be tapered to a smaller gauge than the cutting edge. In tempering drill steel the chisel bit is formed and the steel re-heated. It is then plunged in water for a moment and the edge scraped clean on a stone. The line of colors advances toward the point of the drill and as the edge turns yellow the bit is plunged into cold water.

Method of Placing and Firing the Charge.—In blasting, one of the axioms of the powder man is, "Don't let the powder come up in the hole." The place for the charge is in the bottom of the drill hole. There are several reasons why this condition should be met. One of them—and one which concerns the man who is blasting near other buildings—is that if the charge extends too high in the hole it is likely to cause small pieces of rock to be blown a long distance. The best way to keep the charge down is to "spring" the hole. This consists in enlarging the bottom by exploding a small quantity of dynamite in the hole, with little or no tamping. This enlarges the bottom of the hole, and the operation may be repeated until there is room for the charge. When the shot is fired the rock is simply lifted and drops back into the hole very little or none of it being scattered. Care should be taken not to spring the hole too much, as the effect may be lost. After once springing a hole it must be allowed to cool thoroughly before any powder or dynamite is put into it. Loading must be done with a wooden tamper. Steel bars should never under any circumstances be used for tamping. The material used for tamping should be free from small pieces of stone or other hard material which might produce sparks or damage to the fuse. Moist clay is the best material for tamping, a paper wad being placed between it and the powder. The tamping should be firmly rammed into place. In loading with powder, first spring the hole and then pour in the powder until it begins to rise in the hole, placing the primer as nearly as possible in the middle of the charge.

The best method of ignition is by means of an electric fuse, although safety fuses and blasting caps can be used in the same way. The primer for a powder charge should be made into a cartridge with the cap or fuse in the center of it. This cartridge may be formed by wrapping paper around a round stick, and fastening the loose ends of the paper. When the stick is withdrawn, it leaves a paper cylinder into which the powder is poured. The ends are then folded to enclose the powder. It is not necessary to use strong caps or fuses with black powder. When powder, fuse and cap are used it is necessary to place the primer or cartridge containing the cap at the top of the charge, otherwise the fuse will burn the powder before the spark reaches the cap. The end of the fuse is first placed in the end of the cap (with the fuse not quite touching the composition), and the cap is then crimped tightly to the fuse with a cap crimper. Obviously one should not bite the cap to crimp it, although this is sometimes done. The cap should then be placed in the end of the cartridge, as shown in Fig. 5. Figure 6 shows the proper method of inserting an electric fuse in a powder cartridge.

By far the best method of firing a blast is by means of an electric blasting machine. By electric firing, the full strength of the explosive is developed, and as several holes can be fired at the same instant less explosive is required, as well as fewer holes. There is also eliminated the danger of a hole hanging fire and going off at an unexpected moment. The blasting machine is operated by pushing down a handle which operates a dynamo. This creates a current which by means of the connecting wires is communicated to the fuse. Blasting machines are rated to fire ten, twenty or more holes, i.e., they will fire that many caps. If more than one cap is used in a hole, as is sometimes done, the machines will of course fire a lesser number of holes. There are two kinds of blasting machines in use, one being known as the two-post and the other as the three-post machine. The three-post machine is used to fire a larger number of holes.

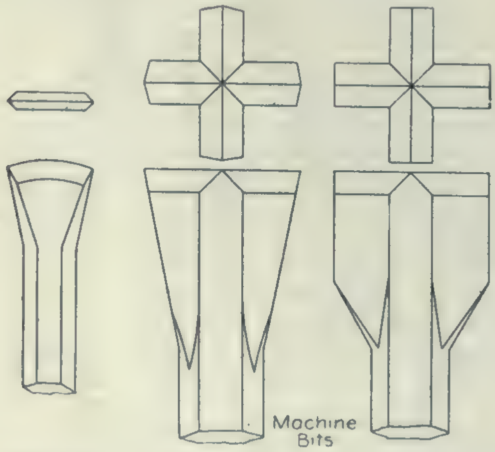


Fig. 4.—Correct and incorrect methods of sharpening drills.

In loading with dynamite, the cartridges are slit on the side with a knife in order that they will pack tightly in the bottom of the hole. Each cartridge must be tamped firmly into place. The primer is placed in about the middle of the charge and the loading is continued until the charge begins to rise in the hole. The charge then should be tamped with clay or with some other similar material, making sure that it is free from loose pieces of stone or hard particles. In placing the priming cartridge containing the electric fuse, the cartridge should be placed at the end of the loading stick and pushed carefully into the hole. Care must be taken to keep the wires straight and at the side of the hole so that they will not be injured by the tamping. The approved method of priming a dynamite cartridge is as follows: With a pointed stick about the size of a lead pencil make a hole in one end of the cartridge; then insert the electric fuse, bending the two wires carefully over the end of the cartridge and tying them thereto with a string, as shown in Fig. 6. In tamping, press the material down gently for the first 8 ins.—after that more force may be used. When a bore hole has missed fire, drill a new one about 2 ft. from it, but do not attempt to drawn the old charge. In blasting with dynamite it is necessary to use a double-strength cap or fuse.

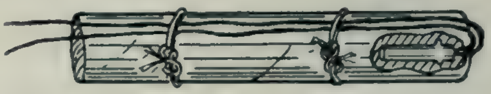


Fig. 5.—Method of inserting cap and fuse in cartridge.

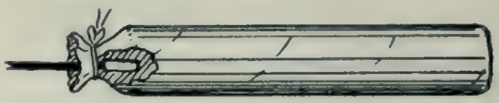


Fig. 6.—Method of inserting electric fuse in cartridge.

An electric fuse consists of a copper shell, inside of which there is a chamber containing a charge which consists mainly of fulminate of mercury. The shell has a corrugation through which the copper fuse wires enter. These wires are insulated except at the places where they enter the corrugation and are held in place with sulphur cement. The ends of the fuse wires inside the shell are connected with solder to a small platinum wire, or bridge. The fuse is exploded by the passage of an electric current through the wire, which heats it to redness. An ordinary fuse of this kind can be used under water, but special caps covered with gutta-percha are made for submarine work.

The electric fuses are connected with wire when several are fired at the same time. This wire is sold in spools and should never be of smaller size than the fuse wire to which it is connected. A "leading wire" is run from the blasting machine to the location of the blast.

The following general directions are given by the Du Pont Powder Company for blasting by electricity:

Drill the number of holes desired to be fired at one time, the depth and spacing of the holes depending upon the character of the rock, size of drill holes, etc., the blaster of course using his judgment in this matter. Load the holes in the usual manner. Avoid taking hitches in the electric fuse wires, as by this very common practice the insulation of the wires may be injured, and the current of electricity may pass from one wire to the other without passing through the cap, hazarding a miss-fire. The electric fuse is best placed when in the center of the charge. In tamping the hole, great care must be taken not to cut the wires nor to injure the cotton covering the fuse wires and not to pull the electric fuse out of place. Allow at least 8 ins. of fuse wire to project above the hole to make connections. When all the holes to be fired at one time are tamped (and one fuse only is used in a hole) separate the end of the two wires in each hole, and by the use of connecting wire, join one wire of the first hole with one of the second, the other or free wire of the second with one of the third, and so on, leaving a free wire at each end hole. When two electric fuses are used in each hole, connect one wire of each of these two fuses together and then connect the holes by the remaining wires of the fuses, as would be done when connecting only one fuse in each hole. In other words, connect the fuses in series throughout. All connections should be made by twisting together the bare and clean ends; it is best to have the joined parts bright. Scrape off the cotton covering at ends of wires to be connected, say for 2 ins., then scrape the wire until it is bright. This makes a clean, fresh connection. Bare joints in wire should never be allowed to touch the ground, particularly if the ground is wet. This can be prevented by placing dry stones under the joints. Insulating tape is also furnished for waterproofing bare joints. The charges having all been connected as directed above, the free wire of the first hole should be connected with one of the leading wires and the free wire of the last hole to the other of the two leading wires. All being ready, and not until the men are at a safe distance from the blast, connect the leading wires, one to each of the projecting screws on the front, side, or top of the blasting machine, through each of which a hole is bored for the purpose, and bring the nuts down firmly on the wires. Now, to fire, take hold of the handle for the purpose, lift the rack bar (a square bar, toothed on one side) to its full length, and press it down quickly with all the force possible, bringing the rack bar to the bottom of the box with a solid thud. Do not churn the rack bar up and down. It is unnecessary and is harmful to the machine.

Power of Explosives.—With reference to blasting, there are three degrees of power exerted by explosives, depending upon the nature of the explosive or upon the conditions under which it is used. An understanding of this will aid in getting the best results. The explosion of gunpowder is merely a rapid combustion. If gunpowder is lighted in the open it simply flares, or burns without exhibiting any great amount of force. If, however, it is confined and ignited its combustion causes an explosion, because the expanding gases meet with resistance and are obliged to overcome it in order to expand. The difference between combustion, explosion, and detonation may best be illustrated by means of dynamite. If a stick of dynamite is ignited in the open it will burn rapidly without exploding and will produce a thick poisonous smoke. If breathed in quantities this smoke will cause illness or even death. If a stick of dynamite is confined and ignited it will explode but will produce the same fumes. A weak cap will explode dynamite with considerable force, but the same fumes will be produced to some extent. On the other hand if a triple-strength cap is used the dynamite will detonate with great violence, producing little or no smoke. The smoke in these cases might be said to represent lost or wasted energy. Dynamite must be detonated with a strong detonator to get the best results. Firm tamping is necessary for the strongest detonation, as any air spaces permit the gases to expand without doing any useful work.

Instructions For Use of Explosives

Finally, a few words of caution in the use of explosives will not be amiss. Do not smoke while handling explosives or handle them near an open light. Caps and electric fuses are extremely sensitive; do not carry them in your pockets and do not store them in the same building with explosives, and never try to open or tamper with a cap or electric fuse. Never tighten a cap around a fuse by biting it with your teeth. There are crimpers made for that purpose. Do not handle or store explosives in or near a residence. Always give a hole time to cool after springing it before loading. Use only a wooden rod for tamping. Take plenty of time before you approach a miss-fire if you are using a powder fuse, for it will sometimes hang fire and go off at an unexpected moment. Do not try to draw out a charge which has not been fired. Drill a hole near it and fire the new hole. This will also explode the old one. Use only one kind of an explosive in a hole, unless you are using one as a primer for the other; as some explosives are quicker than others and the effect of the slower one will be practically lost, the quicker one opening cracks in the rock through which the slower one blows out. Always use double-strength caps or electric fuses when blasting with dynamite. When putting in the primer with the tamping stick do not tamp, but press gently until it touches the main charge. Do not load holes too high, as it gives poor results and is dangerous. In general, if explosives are carefully and sensibly handled they may be used with comparative safety.

Renewing Wood-Stave Pipe

IN January, 1901, the city of Seattle, Wash., put in service a 42-in. wood-stave pipe 22 miles long, which was built the preceding year to bring the city's water supply from the Cedar River. The staves used in the pipe were 2 x 6-in. native Douglas fir, dressed on both sides, cut to radial lines on the edges and cinched together with individual steel bands. After seven years of service some staves began to show signs of failure due to decay, and since that time the pipe has required some repairs each year. As much as 500 to 1,500 ft. has been entirely renewed at a time in some seasons. It is not planned to replace all the remaining original parts of the line at any one time; instead, the renewal will be made little by little, it is reported, replacing only those sections which manifest serious decay.

The rate of decay is said to vary less in different sections of the pipe as a whole than it does in the individual staves. In some cases a perfectly sound stave is found alongside one entirely decayed. The results of erosion also varied with the individual staves, the slash-sawed staves showing considerable wear at points where edge-sawed staves were practically intact. In general the quality of the timber used is thought to have had more to do with the durability of the pipe than any other cause.

Experience with this pipe, water department officials say, indicates that it would be possible to materially increase the life of such pipes by carefully selecting the timber with particular reference to soundness of fibre and conditions of sap.

Economies in Contracting Operations

Abstract of an Interesting Article (by Dr. Sachs in Le Ciment Arme) Devoted to a Consideration of How Forms and Form Work should be Accounted for in Reinforced Concrete Construction

THE reinforced concrete industry presents some difficulties, at least in number, unknown to others; the manufacture of artificial stone alone offers similar difficulties, due to new equipment, the need of which is not felt, to technical ignorance and to lack of business knowledge. These things are not the cause of lack of success on the part of contractors in reinforced concrete, except in the case of small operators, who have permitted themselves to be drawn into undertaking this special work and have hastily gone out of the business, having burned their fingers. It may be stated that actually, in Germany, the great bulk of work in reinforced concrete is undertaken by firms with large capital, directed by engineers who are specialists, and by experienced business men. This is all the more reason for surprise at the frequent errors into which they fall. The matter is not to be explained by the closeness of competition. No one complains of lack of business, but it is nevertheless true that firms foolishly run after new business and in order to secure it do not hesitate to allow themselves to bid at prices which are not sufficiently profitable. Since the management cannot be accused of lacking technical and business knowledge, we are led to think that, if they appear to overlook the fundamental principle of all business dealings, "rather no business at all than business done at a loss," it is because they do not take into account real cost prices or they do not have a sound accounting system. A few examples will demonstrate our thought and the importance of errors which are committed.

There are some firms which by reason of their professional ability and the important undertakings which they have carried to a successful issue have acquired such a reputation that they are given new work without having it submitted to competitive bidding. These firms, being favorably situated and not being obliged to count every penny, can satisfy every rule of the art.

Price-Cutting Competition Undesirable

But, except in these unusual cases, work is generally let to competitive bidders. It is admitted that of late years some reforms have been introduced in these matters, at least so far as municipal undertakings are concerned.

The general objection to the system of awards and the abuses to which it gives rise, together with a clearer intelligence on the part of those who have the interests of good construction at heart, have largely served to improve the old customs. In many localities it is pleasing to note that the specifications are now more just to the owner and to the contractor and if this tendency is not more general, the delay must be ascribed to the difficulty of reconciling the interests of these two. There is a marked tendency to do away with the obligation to award the work to one of the three low bidders, since experience has shown that the principal factor of success of the enterprise is the integrity of the man who undertakes the work.

Unfortunately, these considerations are taken into account by few only, and there may be noted in the majority of tenders some striking differences between the high and the low bidder. These might be explained by the newness of the industry, comparing them with the slight differences noted in bidders on construction in metal, where the raw materials are priced on bases which vary very little. In steel construction, the conduct of the work plays an important role and the price of only a few pieces of work can be definitely fixed by regulation. The slight variation in the bids would result from the long experience acquired by iron and steel contractors, which permits them to know within close limits cost prices and miscellaneous expenses. There are expenses which constructors in reinforced concrete do not take into account and among the latter is that of form work, which will be taken up later.

Dangers of Sub-contracting

There is one serious fault of certain managers, that of confiding their work to general contractors. There should be every confidence in the special training of the firm making the tender, that it limits its activities to concrete work. It is true that the general contractor makes easy the work of the managers dealing with him. But is there ever a contractor who knows all branches of construction equally well? No. So he goes to sub-contractors for carpentry work and masonry, whom he puts in competition and from whom he secures close figures, though at second hand. The dangers of such a method are obvious, since the general contractor, who cannot know everything, has not the knowledge necessary to control the work of his sub-contractors; and if he undertakes work outside of his specialty he runs the risk of running over his costs, which he has probably not calculated correctly, and may suffier a considerable loss.

Need of Specialists in Concrete Work

The constructor of reinforced concrete should refuse all general contracts and owners and architects should avoid giving work to general contractors. The practice simplifies their work but exposes them to serious consequences. In these modern times, specialization is a recognized institution; the constructor of reinforced concrete cannot undertake general contracts and, still less, build on his own account.

Many firms have a number of representatives who solicit their business. Their immediate sphere of activity is too small and work is sought at a distance, on all sides. The representative who is a favorite with the management announces that his firm can have a piece of work if it will consent to a reduction in price. So the firm reduces its price. But, a few days later, another firm makes still more advantageous offers for the same work. The representative counsels his firm to meet any competing bid, if it does not wish to be eliminated forever. The representative always gains his point; he cares little whether or not his firm suffers a loss; in any event, he has made his commission. A loss does not prevent his firm from being influenced in the same manner again, until, gaining wisdom through repeated losses, it rejects the representative's advice, and the latter, in a rage, goes over to the camp of the enemy.

Business at Cost Poor Policy

On other occasions, more frequent than is generally supposed, the contractor who has already been awarded some contracts at a good price, being assured of a good year, says to himself that he can accept some business at cost, thinking by this means to reduce his general expenses. This reasoning is simply self-deception, since the new work requires an increased force, if his ordinary staff is already occupied, as well as new material, with its wear and tear to figure on, and increased expenses of financing.

Bad figuring, outside of all technical valuations, which cannot be treated here, since we desire to limit ourselves to commercial considerations, is related to superintendence, which plays so large a part in the success of an enterprise. Unfortunately, honesty is not too common a virtue, and the activities of a few foremen may spell the ruin of an enterprise. We shall give one example only.

Handling the Purchasing Department

In one large undertaking, the foremen ordered the material direct from the supply houses and reported their purchases to the office, which made accounting to the management, expenditures being evidenced by vouchers checked by the office and therefore considered correct by the cashier. No irregularity could be suspected without collusion of three parties, the supply house, the chief bookkeeper and the contractor.

Nevertheless, a simple chance brought to light an abuse of confidence in a single enterprise amounting to more than 26,000 francs, which the three parties had divided.

Supervision here was lacking in two important points—a record of the arrival and the delivery of materials; a check record in the office of the value of materials ordered and used, and above all, the observation of the management, comparing these quantities with those normally observed.

Leaks in Figuring Form Costs

The weakest point in reinforced concrete contracting lies in figuring form work costs and carrying them inaccurately on successive balance sheets. Some firms credit the forms account with the quantity used in each job; others deduct at the end of the year from the debit of the forms account a certain percentage representing the estimated value of the wood used; still others take at the end of the year an inventory of stock on hand. No fault can be found with the latter procedure unless the reality does not correspond with the estimate—and here is the milk in the cocoanut. The percentage taken usually runs between 30 and 60 per cent.

The firm that bases its figures on 30 per cent. is deceiving itself and its stockholders, while in reality it has suffered a considerable loss. Some firms escape this self-deception by taking an inventory of their stock of lumber every year, but this procedure is accurate only when the latter is estimated at its real value and not at its invoice value. To be perfectly secure it is proper to combine the two plans. The inventory is taken and the stock put in at its true value; at the same time figures are taken as above on the 60 per cent. basis and the less favorable of the two results is put in the balance sheet.

On current work, it may be estimated with a view to the figures at the end of the year, that wood can be used once and a half a year and that each use consumes one-half of the value of the wood, which amounts to figuring that the same wood can be used two and one-half times in all.

Essentials in Accounting

The accounting of work under construction is another rock on which the balance sheet may split. Suppose that it is a question of a firm with a capital of 1,000,000 francs, which desires to show a net revenue of 10 per cent., or 100,000 francs. By taking work under construction into account, which may amount to several million francs, increasing or diminishing by 100,000 francs, this is an easy matter, even for conscientious managers; for deduction is a very elastic thing.

The law requires that the value of merchandise (and this must certainly include work under construction) shall be carried on the balance sheet at the cost price of the supply house and not that of the firm. The law, however, makes a wide difference between these two terms, meaning by the former an expenditure of any kind necessitated by construction, including raw material, salaries, inspection on the job, cost of operating machinery—in short, all the expenses de visu, whatever are the special conditions of the work being done. Therefore, one ought not to figure in this the general expenses of management, the depreciation of buildings and machinery, incidental expenses of the business and so on. If these expenses are added, the law indicates the figure obtained by the cost price of the firm, which, increased by the net profit, constitutes the selling price. It is unfortunate that not everyone is in accord in setting these figures in practice, and for this reason the item of work under construction ought to be estimated with great care; no one can have a proper idea of the exactness of the accounting without knowing the bases on which it is made. Examination by an auditor is not very valuable, since he has not the necessary technical knowledge and can rely only on the explanations given by the technical advisers of the management. I once ran across a case in which the accounting of the work under construction showed the profit hoped for and who knows how many similar cases there are?

I believe that cost price should include the following items:

Raw materials (sand, gravel, steel, cement, forms, etc.), to which should be added the costs of transportation and unloading:

All salaries and superintendence in the work;

Traveling expenses of the management and its representatives;

Material used on the job (nails, coal, grease, etc.);

Lumber for forms, estimated at 40 per cent. of its value, on the hypothesis that in the inventory of the lumber, 60 per cent. of its cost price has been dedeucted; if less is deducted the item of lumber used in work under construction shall be lessened to correspond.

No other expenses, including depreciation of machinery, shall be added.

There is still another source of error to be guarded against. Some firms carry on the balance sheet the expenses contracted at the supply house only; others determine what work is still to be done, and its cost price and figure the difference between the known expenses of this work and the total of the business. Both of these plans lead to grave mistakes. In the first case, it is not taken into consideration that the price on which the bid has been based may have been figured incorrectly, so that the completed work may represent a loss. In the second case, if one is content to deduct the work remaining to be executed, the balance sheet contains the total profit, even when the smallest profit must be overlooked.

To avoid self-deception, both methods will be used.

Here is an example, taken from actual work, which shows the differences in result, according to the method used:

The bid was 500,000 francs and in this sum were included 10 per cent. for general expenses and 6 per cent. profit. The net cost should, therefore, have been 500,000 francs less 80,000 francs, or 420,000 francs. In reality it amounted to 459,000 francs, or 7 per cent. more than was calculated.

The expenses shown by the balance sheet were 300,000 francs; in reality they should have been lessened by 7 per cent. and 279,000 francs written.

The different procedures of accounting would have given:—

(1) 30,000 francs, or 21,000 francs too much.

(2) Figuring a fraction of the general expense of the whole contract, 300,000 francs + 35,000 francs, or 56,000 francs too much.

(3) Taking the percentage of the profit, 300,000 francs + 35,000 francs + 21,000 francs; or 77,000 francs too much.

(4) Taking the price of the bid, less the work still to be done (a very popular method) 500,000 francs — 141,000 francs = 359,000 francs, or 80,000 francs too much.

(5) It would have been accurate to deduct from (4) the estimated general expenses and the profit, or 359,000 francs — 80,000 francs = 279,000 francs, and this figure would have been adopted because it was lower than (1) and still it would not have been very close to the actual facts.

Water-Bound Macadam Roads[*]

By Joseph W. Hunter

THE macadam road of today takes its name from that illustrious pioneer road builder, a Scotchman, John Loudon Macadam, through whose influence the condition of roads in Scotland and England was greatly improved more than a hundred years ago. Today the "water-bound" macadam road is considered by many as a relic of the dark ages and the road-builder who advocates the laying down of such a road is apt to be considered a man with antiquated ideas, a fossil, a man far behind the times and speed of the twentieth century. The writer does not agree with this view. Every system of road or street improvement has its place in the great work of making better the roads and highways of today. A system of highway improvement as used in the great centres of population, where the traffic is dense and almost indeterminable, if applied to the rural districts of the State would be considered a piece of folly not to be tolerated.

The brick-paved road and the concrete road have their uses and are the types of road to be laid down in certain localities and on certain kinds of soil. The bituminous macadam and asphaltic macadam roads are in much favor at the present time as having an ideal surface to travel over, being less dusty and more nearly waterproofed than other surfaces and said to be less costly to maintain. This, however, is problematic and subject to experiment and proof. For highways that are main lines and subject to extensive motor and other vehicle travel, the bituminous macadam in connection with the brick pavement immediately adjacent to the centres of population is undoubtedly the better method of construction.

Along many of the most traveled roads, there is a neutral axis or section of the road that is but little used which can well be improved as a "water-bound" or telford macadam road. A macadam construction is all that is necessary on many miles of lateral roads or roads in a purely rural community, or where motor vehicle traffic is light, the cost of construction being less than that of other kinds of construction and the cost of maintenance, if properly done and done at the right time, will not be more than one-half to one cent per square yard per year; if this amount is expended each year the public will have a good surface to travel over, not only some time, but all the time. "Water-bound" macadam has two faults as an ideal pavement for light traffic, or on the ordinary country road. One of these is the tendency to break up under motor vehicle traffic and the other is its liability to absorb water. These can readily be overcome by the application of a bituminous wearing surface. In this connection and for the purpose of supplying a base for a bituminous or asphaltic cement top or surface, I believe that "water-bound" macadam makes as good, if not better, foundation than concrete.

It has the inherent stability and lacks the creep or shear in expansion and contraction of its aggregate. It is more resilient, causing less wearing on the surface, consequently permitting of a thinner working surface than a more rigid or unyielding concrete base. "Water-bound" macadam that is well shaded will but seldom ravel or become dusty, as the moisture is held in place and not evaporated. Usually a "water-bound" macadam laid on or over a heavy damp soil does not become dusty. It may ravel in very dry weather, but soon recovers after a rainy or damp season. This is notably so when the surfacing is composed of limestone.

If water is convenient and properly applied to the surface of a "water-bound" macadam road, no such road should ravel or become dusty. The water should be applied at night so that it may have an opportunity of penetrating into the surface and not evaporated by the sun or converted into steam upon coming in contact with the superheated surface. The watering of a road surface, if the material is adjacent to or of easy access, is a cheap method of maintenance, costing about two to three cents per square yard, where the price paid for water is from 75 to 85 dollars per million gallons. If the water is obtained from a stream along the roadside the cost will be less.

The external forces to be overcome in traveling over a highway are usually gravity, friction, collision and air. Gravity and friction are in a measure overfor if the highways should be perfectly straight and at the same time level, two conditions that are rarely obtained in the same road. The overcoming of the external force of collision, as well as that of friction, depends upon the character of the surface. A hard smooth surface offers the least opportunity for collision; friction and gravity are more easily overcome and consequently less tractive force is required in propelling a given load over a given distance. With a hard smooth surface and a more rapidly moving vehicle, the air pressure, or resistance, becomes greater and in a measure counteracts the gains made for surface or wheel friction or traction.

---

[*] Paper presented at the Tenth Annual Convention of the American Road Builders' Association.

What material will give the best surface for rapid, safe and economical travel and at the same time offer the least resistance to gravity, friction and collision and also accommodate both horse and motor vehicle traffic? Bricks make a hard and comparatively smooth surface, but the external collision force is hard to overcome and presents a considerable obstruction or resistance to a rapidly moving vehicle; for heavy or slow traffic this resistance is not apparent. A concrete road is subject to the same criticism, except that the collision force is not so great. Both a brick and concrete surface is objectionable for horse traffic. The ordinary "water-bound" macadam surface or telford macadam surface is a better one for animal traffic, and if properly maintained is equally as good for motor vehicle traffic. The collision force will not be so great as on a brick pavement, but tractive force will be slightly increased.

The one surface that more nearly meets all the conditions as giving the least possible resistance to collision, friction and gravity in saving rapid, safe and economical travel and at the same time giving a surface practically dustless and waterproof, is the asphaltic macadam surface. The one drawback to such a hard smooth surface, which is not found in the "water-bound" macadam surface, is its tendency to becomeslippery in wet weather, thereby becoming dangerous to horse traffic.

A better and more uniform surface of "water-bound" macadam will be obtained when more care is given to the preparation of the foundation upon which is to be placed the crushed or telford stone; when more care is taken in the selection of the mineral aggregate, cubical instead of triangular, oblong, or semi-round stone used, stones that under traffic will bond together, and only of such hardness as will be kept bonded by the traffic, much of the ravelling of "water-bound" macadam is due to the action of the elements and lack of sufficient traffic over the surface—when more care is taken in placing the top course of stone, spreading it in from the side of and not dumping it in the middle of the road and then spreading or levelling the material; and with more care in applying or feeding screenings and water and in rolling. Such a surface will last longer without repairs and be an ideal surface for ordinary travel, both horse and motor vehicle, and one that will make as good a foundation for an asphaltic macadam surface, as can be laid, when the increase of traffic warrants such construction.

Many of the old turnpikes that now form parts of the system of State highway routes will be maintained as "water-bound" macadam roads until such time as the Department is warranted by reason of increased traffic in laying a surface of other material. These turnpike roads were originally built and maintained for years with stone, broken by hand on the side of the road and then spread on the foundation prepared to receive them. No rollers were used, but the traffic that passed over the stone bound them together. It was by this method that Mr. Macadam reconstructed the old pike roads of England. In the counties where limestone is plentiful most of the 700 miles of toll roads in the State are to be found, many of such roads having an ideal surface, save for a dusty tendency at times, such surface being maintained solely by the traffic, no rollers being used.

I believe that with so many opportunities to make use of "water-bound" macadam economically and to advantage, the time has not arrived—and will not arrive for many years to come—when that method of reconstructing public highways can be dispensed with. It will be in use when some of the methods which are being experimented with today are cast aside.

At the corner of Tenth Avenue and Thirty-sixth Street, New York City, the architects, Goldwin, Starrett and Van Vleck, have provided plans for a twelve-storey skyscraper, in which the entire front of the building and its interior sides are to be of glass. In fact, 78 per cent. of the walls will be of this material. There will be no openings in the glass facade except those in the front of the building for emergency purposes, but which will not be visible from the street. It is estimated that the structure will cost approximately 600,000 dollars, of which amount 78,000 dollars will cover the cost of the glass. On the interior the glass will be a specially polished plate, and for the exterior surface will be specially treated plate that will not transmit heat waves into the interior.

Artificial stone is made, according to a patent by W. Laufer, 4 Gertruda, Cracow, Austria, as follows:—Granite or greywacke, basalt, porphyry, or the like in coarse and in fine granulations, are mixed with aluminium phosphate and sodium carbonate in about the following proportions: 40 parts of coarse porphyry, 50 parts of fine porphyry, such as porphyry tuff, 6 parts of aluminium phosphate, and 4 parts of sodium carbonate. The mixture is moistened, pressed into blocks, and heated to about 1,000 deg. to 1,200 deg. C. Silica and lime may be added in quantities of from 5 to 10 per cent., to regulate the clinkering. To increase the cementing power of the mass, colloidal alumina may be added in the proportion of from 2 to 8 per cent. aluminium hydroxide in the whole mass.

A wooden derrick-boom broke in half while raising a load of six tons of steel columns from the street to the sixth floor of a building now under construction at Broadway and 37th Street, New York city, on November 29. The derrick was installed on the sixth floor, and the boom had lifted the load 4 ft. above the ground when the topping lift snapped, dropping the load to the street, and the boom upon the steelwork of the sixth floor. The boom (which was 70 ft. long by 14 in. in diameter) snapped at the point where it struck, the overhang falling to the street. Ravitch Bros., of New York City, who are handling the structural steel contract, state that this same derrick hoisted loads of from 20 to 30 tons each about ten days ago on the same job.

The province of Quebec constructed about 225 miles of macadamized roads and about 60 miles of graveled roads last year. About 40 miles of roads between Quebec and Montreal are now underway, and the King Edward Highway is nearing completion. In all about 900 miles of roads have been either constructed or extensively repaired during the year.

Advantages of Reinforced Concrete in Factory Buildings

By Harry C. Spillman.

THE great changes which have occurred in manufacturing during the last decade have brought about a new epoch for industrial buildings. Improvements in modern machinery, methods of operation, Scientific Management, high-speed steel and short cuts in production have demanded buildings suitable for the line of manufacturing they are intended to house. The highest efficiency can only be obtained by having buildings planned to secure these ends. The small factories of a few years ago are mammoth institutions to-day. The owners of these plants have discovered that their plants have become many times larger than their fondest hopes in the early days of their organization, and many of these owners of manufacturing plants are face to face with the vexing problem of more room.

If these owners will study their present conditions they will find their plants, from the manufacturing standpoint, in a more or less chaotic condition and their manufacturing costs climbing up. Increased room demanded in one department has blocked the expansion of another; machines have been crowded into small spaces without sufficient room for the operators and material; the trucking aisles are too narrow and the material, instead of having a continuous routing from the rough stock room through the manufacturing and assembly departments, takes a zig-zag course, retracing its steps and meeting itself going and coming in all parts of the factory. This requires a small army of truckers, inspectors, and stock chasers to keep this material in process of manufacture, and the department heads are becoming worried over delays and cancelled orders.

Industrial Engineering

The only solution to this problem is a factory built especially for the work intended. This has created a new engineering field, as it calls for an engineer who can plan buildings suitable to meet the exact conditions and the routing of material without retracing its steps, so that it travels in straight lines. This labor-saving, in cutting down to a minimum the trucking of material, will often save the manufacturer a sufficient amount in his manufacturing costs to warrant the expenditure for a new plant. The engineer must plan for future expansion, so that each department can grow almost indefinitely without running into or crowding out another department. All factories demanding larger quarters are growing concerns and their new plant should be capable of taking care of all future requirements. If this point is lost sight of the owner will find within a few years that he will have to rebuild again. These are the main features of making preliminary plans for factory buildings, and it is always best to lay out the factory and purchase the property to take care of the lay-out instead of trying to make the building fit the property. If this is not done the buildings will have to be altered and rearranged, and the plants will not be entirely satisfactory when completed. It took years for the idea to be fully realized, that intelligent planning means economy. An expert engineer can save many times his salary during the construction of the building, and his fee will pay big dividends in after years.

In choosing a site, properties located away from the heart of the city near the suburbs, but having good street car connections and shipping facilities, make the best locations. Property in such a locality is cheaper, and there is sufficient room for future expansion; moreover, living conditions for the men are far better. It attracts the best class of workmen and the men are more contented than in the crowded shops in the city.

After the preceding requirements are carefully considered, real designing of the factory commences, and the type of building is one of the first problems. Reinforced concrete buildings are popular, and certain facts concerning this type will be of interest. They are lower in ultimate cost than other kinds of buildings; in fact, their first cost comes very close to that of slow-burning mill construction and is lower than that of fireproof steel construction. Concrete has a low depreciation charge. In reality, as concrete becomes harder with age, a reinforced concrete building originally designed for four storeys will allow a fifth floor to be added after the building is three or four years old. Authorities on depreciation give a maximum depreciation of 1.5 per cent. per year and some as low as 0.75 per cent.

Fireproof and Sanitary

A reinforced concrete building is fireproof. This is of high value to a manufacturer in reducing his insurance and preventing a bad fire in his factory, which generally gives a manufacturer two or three years' set-back, and often proves disastrous to his business career. Fires of intense heat penetrate concrete less than an inch, which does not allow the reinforcing steel to become exposed. Replastering the thin layer of concrete which the heat has disintegrated, the replacement of the broken glass, and a new coat of paint will make the building as good as ever.

The sanitary qualities of reinforced concrete buildings bring forth another advantage, as a building of this construction is free from dry rot and dampness and it can be thoroughly washed out with a hose without damaging the building. Sanitation makes healthful working conditions which have a direct bearing upon the efficiency of the workmen.

Other Important Characteristics

A characteristic which makes reinforced concrete buildings stand out from all other classes of buildings is the load-carrying capacity and the ability to absorb vibrations. A floor designed for 150 pounds live load per square foot will generally carry a load of two or three times this amount without showing any deflection, and in case a heavy load is concentrated on a small area, it will distribute this load over a large floor area.

Reinforced concrete buildings are built of the skeleton type, which allows a maximum of glass area; generally, 75 per cent. of the wall area is glass. The flood of daylight throughout the plant increases the workmen's efficiency, and also cuts down the lighting bills. The large window area allows more ventilation and enables the owner to increase the width of the buildings and still have sufficient light at the centre.

But little difficulty is experienced in installing machinery in concrete buildings. Embedding small strips of wood in the concrete and nailing to these strips a sub-floor of 1⅛-in. pine and over this a maple floor about 1⅛-in. thick, makes an excellent floor for manufacturing purposes. It gives 2¼-in. thickness of wood, so that the machinery can be easily fastened by means of lag screws. This floor is easy on the men's feet and shows excellent wearing qualities. By means of embedding in the concrete ceilings cast-iron spools threaded for a ¾-in. bolt, or placing long metal inserts in the concrete ceiling, shafting, piping and electrical conduits can be easily suspended. For attractive appearance reinforced concrete buildings can compare favorably with other types of constructions. By the clever use of ordinary pressed brick and cement plaster a well-designed reinforced concrete building will equal in beauty the most expensive buildings made up of brick and cut stone. Beauty in manufacturing plants is of recent origin. Its value has many factors which make it impossible to measure. Workmen take pride in the place in which they work. The advertising value is of importance, and neatness and beauty raise the property value. Such a building is a source of pride to its owners and expresses the ideals of the company to the public.

The remarkable development of reinforced concrete has brought upon the market many different designs which have certain advantages for the work intended. The girder type works out very successfully for long spaces, if it is desired to have the building entirely free from interior columns, with large, unbroken floor spaces. The outside building columns are placed on about eight-foot centres and a heavy concrete beam is poured from column to column across the building. The floor above is usually a concrete slab (about 6 in. deep) resting directly upon these girders. The only objection to this type of construction is the great depth of the concrete girders, which sometimes is as much as five feet.

If the building has interior columns the builder has the choice of a floor supported on beams, girders and beams, or a plain flat slab. Using the former method, there is some difficulty in running pipes and electrical conduits, as the beams offer an obstruction.

Flat Slab Construction

The flat slab has one advantage in that the ceiling is entirely clear of obstructions, and shafting, piping and electric wiring can be easily installed. There are several methods of flat-slab construction. The best for manufacturing plants is a solid concrete slab of 8 or 10 in. thickness. This adds additional weight, which has to be taken care of in designing the building, but this extra weight absorbs all vibrations from moving machinery which can be placed on any floor. Another flat-slab scheme is to use hollow tile and insert a narrow concrete beam between the various rows. This method calls for the tile to be plastered underneath in order to obtain a finished job and gives a lighter slab. It makes an excellent floor for offices and stock rooms, but lacks the necessary weight to absorb machinery vibration. It is customary to design reinforced concrete buildings with the interior columns spaced between sixteen and twenty-five feet, according to the use of the building.

The reinforced concrete building successfully answers all problems in building construction for manufacturing purposes; when completed it will be as substantial as though cut out of solid rock, and will possess the combined qualities of granite-like concrete mixed with steel.

Imperfect Plans and Specifications*

By J. M. Vollmer†

IN commenting upon the building problem there is one phase that seems to have entirely escaped notice or has been passed over for the reason that to rectify what is, without doubt, a serious drawback to the building industry, would entail a radical reform in a custom that has existed for a long time—a custom that has nothing to sustain its existence except a passive submission on the part of the contractor.

The phase to which I allude is that of bidding upon imperfectly drawn plans and specifications. The intent of plans is to show what is required and specifications should furnish a supplementary description of the work desired. This makes it imperative that all plans and specifications should be very plainly drawn and worded.

Statement of the Contractor's Position

By using the old expression that "the tailor cuts his garment according to the cloth" the building contractor's position is clearly stated with the possible exception of fine residence work, which is usually planned and built to suit the whim of the owner. With regard to building generally the paramount question is, "Will the investment pay? Buildings for mercantile uses should be considered plants, whether intended for stores, offices or factory, and the cost of erection should not exceed the point where it will fail to produce a reasonable return on the money involved.

Here, in particular, is where the contractor resembles the tailor, as it is his duty to erect the structure according to the plans and specifications handed him by the owner and architect. This, in our opinion, is the greatest problem in contracting, for in almost every case the bids submitted exceed the original estimate made by the architect.

This condition is due entirely to the obsolete methods of preparing specifications and plans. Every branch of the building trade has advanced. Modern ideas and methods have supplanted old ideas and methods, new materials have been introduced and favored on account of their being more adaptable. Practically everything in building material is considered from the sanitary and fireproofing standpoint. In fact, progress has been made all along the line, save in the letting of work.

Old Methods of Bidding

The old method of out-guessing your competitor by bidding on vague plans and specifications is still in vogue. It would seem that in this day of enlightenment and mathematical precision that quantity and quality could be ascertained to the fraction of a penny and that the only difference to be found in bids upon a certain contract would be the percentage of profit expected by the competing contractors.

---

* The Building Age.

† Secretary Louisville, Ky., Builders' Exchange.

The opposite is the case, however, and the cause is directly traceable to the obscure manner in which the specifications and general conditions are prepared. The elimination of the doubt about material to be used by specifying in plain words the character and quality, the exact method of their introduction into the building and furnishing all details instead of determining upon these important points after the contract is awarded would in a large measure prevent the custom of revision of the original plans in order to get the cost somewhere in the neighborhood of the owner's estimate. In other words, get the desired garment out of the cloth submitted.

Undoubtedly a large percentage of work is postponed indefinitely, and the reason, we believe, is that the bids offered were greater than the amount of money destined to be placed in the structure. Here is the problem and the result can easily be found by simply eliminating blanket clauses and obscure passages in the general conditions and specifications. We believe that by doing this we will not only find the cause of all building difficulties, but will insure a decrease in the cost of construction from 10 to 15 per cent.

The discrepancies between the architect's estimate and the bids submitted would disappear. Blanket clauses are used to cloak and protect. Their appearance in a contract is an admission of fault in the general conditions. Errors will crop out, as it is human to err, and where inaccuracies occur the parties directly responsible for them should bear the cost. In the case where the contractor is to blame, his bond will suffice to reimburse the owner. If the mistake is with the plans and specifications the loss should be at the expense of the owner or his agent.

By removing all question as to what is desired, the owner will be served better and the gambling aspect which has so long attached itself to contracting will be removed, and building for investment will become more profitable.

What Advertising Means to the Contractor

By Charles L. Pitts, Toronto.

MOST contractors recognize the value of advertising and yet many consider it too costly to adopt. Advertising may be costly and inefficient, but it is possible to get excellent results with little outlay. For the contractor advertising may be considered under the following classes: work advertising, general, letter and office advertising. It is a matter of the cost of the work and the ingenuity of the advertiser. For the average contractor the services of an advertising expert are unnecessary, as he himself can devise a form of advertising as will attract the public. Contract advertising must be dignified, but at the same time not too conservative. Individuality is the very life of advertising.

Work Advertising

Work advertising is any form of advertising around the job. Signs, valuable as they are, do not complete this method. In sign advertising some particular colors should be adopted so that in all work even at a distance the sign will be recognized. A sign is often spoiled by too much printing because it renders it indistinct at a distance; it has also a tendency to detract from the dignity of the firm. The idea is to call attention to the work which should reflect the character of the company. The time-honored wording, "carpenter work in this building neatly done by Jeff. Smith & Sons, Phones ——. Reddin Building, Toronto, Ont," looks better if simply worded:

Jeff. Smith & Sons,

Carpenter Contractors

Reddin Building, Toronto

It is understood that the work is in that building and that the company has a telephone. 'Phone numbers are sometimes changed and then the signs have to be reprinted.

There is also the tool box as a valuable aid in work advertising, particularly in private work. The writer knows of an instance where five contracts were secured by a concrete contractor as a direct result of having a neatly painted tool box on a car-track street on which he happened to be working. The tool box should be painted in the recognized colors of the firm and it need not have extravagant wording such, for example, as "exceptional and high grade work." It is understood that the firm considers its work "high grade," but any uncommon device in the construction of a tool box is an advertisement. Adopt one that will attract the eye from a distance, such as:

Bryan & Midlow,

Concrete Contractors,

Wedlaw Building, Toronto

Public and Private Work

Signs, tool boxes, wagon sheds; the more widely the firm's name appears the better. The trick of some small contractors in having a tool box numbered, "gang No. 6" when there are only two gangs actually in their employ, is obviously a false advertisement. Work advertising need not be costly but it must be dignified.

General company advertising as applied to the small contractor takes in newspaper advertising, letters, and signs on places other than actual places of work. In newspaper advertising it is well for the contractor to remember that bargains are not offered, as in selling groceries; what is wanted is simply a statement of the name, place and nature of business, and phone number. For example:

Jones & Weatherspoon

Carpenter Contractors

Large and Small Jobs

10-11 Englehart Bldg. **Phones — —**

A man doesn't look for a contractor until he needs one—not like the bargain hunter when there may be something cheap—therefore sensational newspaper advertising is detrimental because it looks shoddy to men whose business really counts.

Letters are a very valuable form of advertising in private contract work. Even when it is possible to send a letter with a tender there is an opportunity for a good straightforward talk. This is the most important consideration in letter advertising:—talk to the point and in a way to try and convince the reader that good faith is intended. A letter written in a very self-praising strain may be successful in selling "wildcat" mining stock to widows and country school teachers, but it doesn't convince the man with a knowledge of the contracting business. A letter to an architect, for instance, need not go into details about the quantity of material to be used. That is the architect's part of the business. But if it succeeds in convincing that man that the writer of the letter is honest it often brings the business. Every experienced man knows that it is easier to be dishonest in concrete work than in any other form of contracting. Therefore a letter that will convince the architect or builder that the concrete contractor will do honest work will not only get the business but will hold it providing that the work really is honest. A letter should be simple and should not look too much like a circular.

McGILL & ROSS,
Carpenter Contractors,
6-7 Milton Building, Toronto, Can.

John Dough, Esq., Toronto.
Dear Sir:

We are prepared to tender for carpenter work under your supervision on any buildings for which you are the architect and we are willing to leave a stated percentage as a "drawback" to guarantee our work. We are ready to accept your opinion as final in respect to all material.

A member of this firm will call on you at your convenience.

Yours truly,
McGill & Ross.

This is merely a rough form as an illustration without considering any of the general conditions which may be met with in connection with any particular business. Advertising letter-writing is an art in itself. General signs are such signs as may be placed over any storehouse, yard or other permanent place. If there are two or more yards it is well to have large signs and to number the yards. A yard being permanent is unlike a tool box as it is not seen in different parts of the town. Nothing looks more like a false advertisement than to see a "Gang No. 5" box as the only one in evidence when there are only two gangs working. To the contractor who cannot live up to it, overdoing advertising is nearly as bad as none at all.

A prominent Toronto business man gave this advice when his son commenced business as a contractor —"Don't economize in your office furniture." False economy shows more in an office than in any other place. It is not expected that a contractor's office is to be furnished like the office of a bank president, but on the other hand where office furniture consists of a cheap table and a filing system that looks like a schoolboy's desk with an easy teacher in charge is a poor advertisement. People naturally think when they visit such an office that the contractor isn't a very business-like person.

Advertising for the contractor is not a new idea. It is recognized by all construction firms, and to the small contractor, dealing more directly with the public than the large corporation contractor, advertising is one of the most important considerations in his business.

Day Labor and Contract

A large city in the middle west is planning to do a considerable part of its pubilc work by day labor. It proposes to establish a bureau of construction and to secure equipment and a labor organization. Following the plan of some Canadian cities it will then submit bids for municipal undertakings in competition with contractors. Bidding under its own specifications, on its own plans, and doing its own inspection, the bureau quite likely will be able to underbid its competitors on some piece of work. Whether or not the cost of the completed improvement will show a saving over the prices bid by the contractors remains to be seen. Judging from the experience of other cities it will not. In many cases where an apparent saving has been made by day labor, this good showing has been due more to the method of bookkeeping than to the economical handling of the undertaking. By the judicious spreading or omission entirely of overhead costs, interest and depreciation on plant, by the leaving out or changing parts of the work, or by the improper spreading of direct charges, it is possible to make considerable difference between the book cost and the real cost of a certain piece of work.—Engineering and Contracting.

Dogs in field service were utilized in the construction of the National Transcontinental Railway. Their use was described recently by Mr. R. F. Uniacke, bridge engineer of the National Transcontinental Railway, at the Canadian Railway Club. Not only were dogs used to transport the mails over the snow-covered trails, but they were also employed in the summer time to operate a light pile driver used with a pump for sinking 4-in. pipes to secure wash-boring tests of the soil in the river bottom. The dogs were hitched to capstan bars of a windlass on a raft on which the pile driver and pumps were installed.

The effect of frost on the lead service pipes of the city of Liverpool, Eng., is mentioned in the 1912 annual report of Mr. Joseph Parry, chief engineer of waterworks. Between January 28 and February 5 there were reported 10,948 burst lead pipes and 61 burst iron pipes. The consumption of water in and around the city rose from 205,000,000 gal. for the week before the frost to 272,000,000 gal.—an increase of 32 per cent.

Cost of Skyscrapers

A careful record on the structural work of numerous first-class office buildings has been kept by F. W. Fitzpatrick, a consulting architect at Washington, D.C., who has found that a fair average of them is the following cubical cost. The figures are in cents per cubic foot of building:

The foundation cost	1¾
Steel framing	2½
Granite and all masonry	11 1/6
Cornice, roofs and skylights	2/3
Fireproof floors	2/3
Partitions (tile)	2/5
All plastering and stucco	1¼
Elevator fronts and all ornamental metal work.	2
Marble work	3 1/6
Hardware	2/15
Joiner work	1 1/6
Glass	5/12
Painting and varnish	7/30
Electric wiring	2/3
Heating	1 1/8
Plumbing	1/2
Elevators	1
Stairs, scenic structural framing "making ends meet," lamp fixtures, etc. What might be called a fair amount for "contingencies" in such a building, including lesser items not mentioned here but grouped together	4 23/120
Architect's fee	2 3/5
Total	34 5/12

Civil Engineering

By Geo. Fitch in The Engineering Record

A civil engineer is a quiet man with a thick coat of sunburn, who spends his time revising climates, editing the landscape and training up rivers into lives of usefulness. In order to do this the civil engineer does not tear the earth wide open with 100-ton spades or perform other feats of strength. He is usually of ordinary size and if he only used his own hands he could not push around a small creek, let alone a river. The civil engineer does not rely on muscle. When he desires to move a mountain or wipe out a few hundred square miles of desert with a dam he takes his logarithm book and retires to a quiet spot where he fills an acre of brown paper full of figures. At the end of six months he emerges with a tired air and a carload of blueprints and motions to the steam-shovels to come on up and get busy.

The civil engineer is not generally known. This is because he cannot often be found on the street corners or in the clubs or in the act of decorating grand opera with a vast white shirt front. He usually lives in the wilderness in hip boots and a last week's shave. After the ordinary man has lived in a wilderness for a few years his mother wouldn't know him. But after an engineer has lived in a wilderness the same length of time its mother wouldn't know it. The engineer is continually editing and revising nature, rearranging mountains and making rivers back up and go the other way. He is as restless and unsatisfied with the way things look as the woman who always rearranges the parlor furniture while her husband is away so that he may fall over it when he comes home in the dark and receive a pleasant surprise.

The civil engineer has hung railroads on mountain sides, run tunnels under city streets, made oceans shake hands, harnessed up Niagara Falls, made parks out of the Western deserts and has put a reverse gear in the Chicago river. Some day he will begin experimenting with the earth's orbit and we may yet have Christmas at the Fourth of July and a weekly comet service to Mars—who knows. Logarithms and a square law working harmoniously can do almost anything.

Contract Conditions at Vancouver

THE following clauses in the general conditions of contracts carried out for the city of Vancouver by private contractors have been adopted by the Board of Works:

The contractor shall not employ upon the work, or in connection therewith, any workman or employee for more than eight hours in any one day of twenty-four hours during the continuance of this contract, nor shall he employ any such workman for more than forty-four hours during any one week, the intention of this clause being that the contractor shall allow to each of such men one-half holiday during each week during the continuance of this contract. The working day shall commence at 8 o'clock a.m., and end at 5 o'clock p.m., excepting on Saturday, when it shall end at 12 o'clock noon. The noon hour may be curtailed by special agreement between the contractor and the majority of the employees, but not in such a manner as to permit more than eight hours in any one day of twenty-four hours; but if two or more shifts of men are working in one day, the same men shall not be permitted to work on more than one shift, and such shift shall not be considered overtime. Overtime shall not be allowed under any pretence whatever, except when human life is in jeopardy or property in danger of destruction. In such cases, overtime will be allowed until the work is secure from danger, and no longer, except by a written order signed by the City Engineer and the chairman of the board of works, and all such overtime shall be rated at time and a half, and in the event of the contractor employing or permitting any workmen or employees to work on this contract for more than eight hours in any one day of twenty-four hours, or to work more than forty-four hours in any one week contrary to the provisions of this contract, he shall forfeit and pay to the corporation the sum of $5.00 per hour for each and every man whom he shall permit to work over the said eight hours or the said forty-four hours, which sum or sums shall be liquidated and ascertained damages, and shall not be considered a penalty, and may be recovered by action or deducted by the corporation from any sum or sums due or to become due to the contractor under this contract, or otherwise. And it is expressly hereby agreed to by the contractor as to the time of employment of workmen on the said works, and in the event of the contractor making any breach of the said conditions the corporation may, at any time after such breach, by notice terminate this contract, and the contractor shall in such case have no claim against the corporation for compensation or damages by reason of such termination.

The contractor will pay or cause to be paid to any workmen, artisans, mechanics and labourers employed under or in connection with this contract a rate of wages not less than that recognized from time to time by the fair wage officer of the Dominion Government of Canada for the City of Vancouver and surrounding districts as a fair rate of wages for competent workmen, artisans, mechanics, or labourers, when employed in similar work to that hereby contracted to be performed and carried out; provided, however, that notwithstanding anything herein before contained, the contractor shall pay or cause to be paid to all workmen employed by him, or by any sub-contractor under him in the execution of this contract, a minimum wage of not less than thirty-seven and one-half cents per hour.

Conduit Work in a Fireproof Building

One of the most difficult problems encountered in designing the electrical work in buildings of certain classes is that of selecting the best locations for the ceiling outlets. And after the best that is possible along this line has been done it is often necessary, when the building is ready for occupancy, to add new outlets or to change the locations of some of those already installed. Moreover, such revisions of the wiring are quite liable to be troublesome to make in a manner that is satisfactory. To take a specific example, consider the modern type of fireproof office building. The requirements of the tenants on any floor of such a building can hardly ever be fully anticipated while the wiring is being done; the work can only be laid out to meet their probable needs, and then when the arrangement of the offices is definitely known, important changes in the location of the ceiling outlets may be found to be desirable. Thus, at best, it becomes necessary to do more or less of objectionable cutting and patching in the ceiling. This process is expensive, and if the work is not done by skilled workmen the ceiling structure may even be materially weakened.

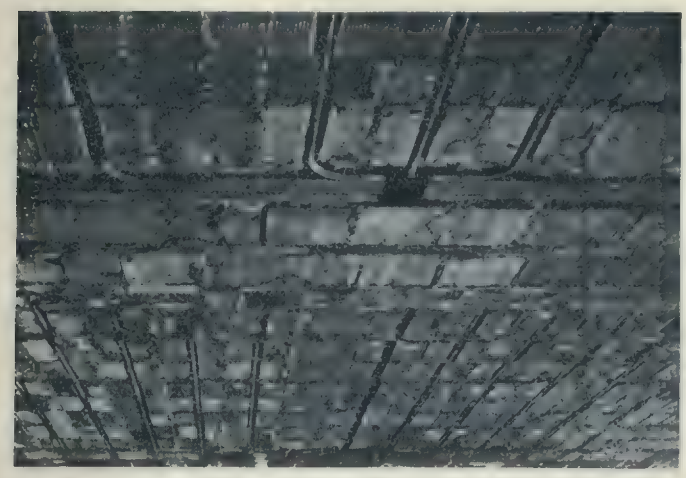


Fig. 1.—Portion of ceiling before plastering.

Having realized the foregoing difficulties, from experience in the construction field, a firm of electrical contractors in Chicago developed a new and very interesting system of concealed conduit construction, not long ago, the principal object of which is to provide new lighting outlets in a building without the necessity of resorting to any objectionable cutting of ceilings and floors and the consequent patching of the plaster. The first installation of this kind is now being completed in one of the large fireproof office buildings in Chicago.

Characteristic features of the construction under consideration consist in the fact that the conduits for the accommodation of the ceiling outlets are placed in the ceiling just above the plaster, and that, by means of a tool designed for the purpose, an outlet can be readily installed at any point in a run of conduit after the ceiling is finished, without the necessity of cutting a hole in the plaster larger than can be covered with a fixture canopy of the usual size. In fact, ceiling-outlet boxes will not be installed on any part of the job until the space on the various floors is rented and the tenants specify where the outlets are wanted.

The Webster Building, in which the system is being installed, is a 12-story-and-basement fireproof structure with tile floor arches. The National Fire Proofing Company made a special grooved tile block and soffit tile for this building, the cost of which, it is claimed, was no greater than that of standard tile. In one or two instances when the tile setters ran out of the ordinary tile, the conduit was spaced to set in the seam between the arches, which demonstrated that this method is also practical.

The conduit was installed 13 inches center to center, almost throughout the ceilings (which is the maximum Universal layout), and was laid on the centering, or temporary planking, used by the fireproofing. The conduit hangers, which hook around the pipe and clamp to the flanges of the I-beam, were then set in place and locked up tight, securely holding the conduits in their exact positions. One end of each conduit run was closed with a gas cap, and the other end terminated in a small junction box. With only two exceptions on each floor, each junction box was the terminal for one end of each run in two adjoining offices. These boxes are approximately 6 by 8 inches, and are provided with a plaster cover with a 4-inch round opening in the center. This is all concealed, as are the conduits, by the plaster. A round flat cover is provided for the opening in the plaster cover, which is drilled for screws and countersunk so that when installed it protrudes only the thickness of the metal below the finished ceiling. When painted over this cover is not noticeable, though as a hand-hole it allows access to the wires and connections from all conduits terminating therein.

These boxes and conduits are flush with the bottom of the tile and are concealed only by the plaster. The home-runs from the junction boxes to the panel cabinet are one-inch conduits over the top of the tile, as is present practice. For greater flexibility all junction boxes are interconnected with one-inch conduits; an idea of this flexibility may be obtained from the fact that a switch in the northeast corner of the floor can be connected to a fixture in the southwest corner without touching the plaster. The junction boxes replaced troughs which it was originally intended to use.

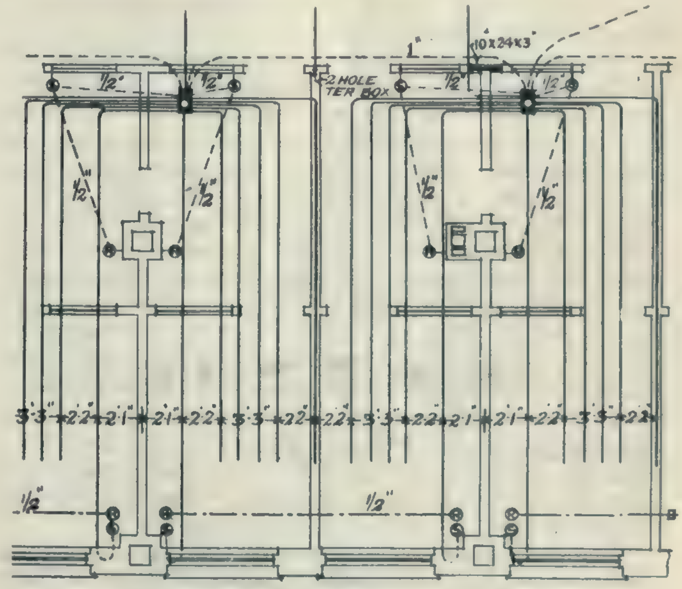


Fig. 2.—Plan of conduit construction.

Switches and receptacles are being installed in columns and outside walls only, where they cannot be covered by future partitions.

A valuable feature made possible by this system as installed in this building is that all receptacle outlets to outside walls are connected with half-inch conduit. This allows the installing of a receptacle anywhere on this pipe at any time during the life of the building. All switch legs terminate in the junction boxes, and at this point may be connected to any or all conduits in the room.

Fig. 1 shows portions of the ceiling before the plastering was done. The method of running the conduits from the junction boxes is brought out very clearly. Fig. 2 is a working drawing of the conduit construction in a portion of the ceiling. Dotted lines show how the junction boxes are interconnected, while the dotted line extending to the right from the junction box in the upper right-hand corner of the figure indicates the circuit from the wire shaft containing the risers from the service board in the basement.

Outlets will be provided by milling out the lower half of the conduit with a special milling machine and fastening a conduit-outlet box to the pipe with U-bolts, the box and bolts being of special design. It is claimed that the conduit can be milled out without disturbing the conductors and that no rough edge or burr will be left at the opening to injure the insulation.—Electrical Review.

The council of the Fort William Board of Trade passed a resolution recently requesting that the Railway Board defer action regarding the proposed station building of the Canadian Northern Railway until the Board of Trade have considered the revised plans.

LETTERS

Educational Facilities for the Clayworker[*]

Poor Men, Poor Products, says Professor Day

Guelph, Jan. 1, 1914.

Editor Contract Record:

I have read your editorial, "Educational Facilities for the Clayworker" very carefully. Knowing the product of the clay tile industry from one end of the province to the other, as I do, I am firmly convinced that there is urgent need for some educational facilities whereby the clay-workers of Ontario may receive technical training in the principles and practice of the industry. Many yards turn out tile of uniformly high quality, others of almost uniformly poor quality, while from some other yards the product is partly good and partly bad. I am glad to say that most yards turn out high-class tile, but from a few yards tile are supplied to the trade that cast a reflection, not only on the individual manufacturer concerned, but to a certain extent upon the industry in general. With a few trained men going out into the industry year by year from the university or technical school these weaknesses would be gradually eliminated and the industry in general would be highly benefited. What is true regarding tile must be true for clay products in general.

As to the best means of providing the facilities for this professional training, I think exception should not be made in the case of this particular industry. The training of professional men for this work should be provided on the same basis as the training of professional men for other lines of industry throughout the province. If it has been necessary for pioneers in other lines of engineering to have courses established by financial assistance from the industries concerned, then the clay products industry should not hesitate to deal with the matter in this way. But if these courses have been established by public assistance through the university and other schools, then a course in ceramics should be provided on the same basis. The need is great and the time is ripe.

I think the question of ways and means of securing the desired end might well form a topic for discussion at the forthcoming convention of the Canadian Clay Products Manufacturers' Association.

Yours very truly,

Wm. H. Day.[*]

Mr. Joseph Keele Cites Growth of Industry

Toronto, Dec. 31, 1913.

Editor Contract Record:

At present there is not an educational institution of any kind in Canada prepared to give men either a full or partial training in ceramic engineering. Many of our universities already give almost two-thirds of the course necessary for the work, which includes geology, physics, applied chemistry, electricity, heat engineering, etc. The accommodation, equipment, and teaching staff required to give the complete course in ceramics could be added at a comparatively low cost. Most students after graduation would have to enter the employment of a manufacturer in some line of clay wares, so as to get practical experience. Certain of the large firms in the United States will give a year's varied employment to any student graduating in ceramics who applies for a position, with the promise of permanent employment if he excels in any of the departments of the industry.

The Ontario Clayworkers' Association made an effort five years ago to have a course in ceramic engineering established in the University of Toronto. The committee appointed by the Provincial Government, consisting of three of the members of the faculty of applied science and two members of the association, reported favorably on it, but the university authorities were not prepared to carry it out.

Considering the fact that the value of the output of clay products for the year 1912 was more than ten and one-half millions, and that Ontario was credited with about 45 per cent. of this, it is important that the clayworkers of the province should be granted their demands for technical education.

Yours truly,

Joseph Keele.[†]

President Falconer's Views

University of Toronto, Dec. 13, 1913.

Editor Contract Record:

I have read with a great deal of interest your article on "Educational Facilities for the Clayworker" which appeared in the issue for December 10. It seems to me we must before long develop greatly our educational facilities for those who are engaged in this industry, which is becoming one of the largest in the Dominion, and is of especial value to the people of this Province and the district around Toronto.

You are right, I believe, in making a distinction between the education that the University may afford and that which can be provided in the Technical Schools. We have made a very small beginning in the way of giving instruction in Ceramics for the man who is to become an engineer, and I have no doubt that before long this will be developed into a department of considerable importance. Indeed, as you mention in your article, nothing but financial difficulty has stood in the way of its development long before this. We are at present endeavouring to lay the foundation of such a department. This, however, would be intended, as in the case of the other university faculties, to train the man who is to take charge of large constructive works, the investigator into the quality of clays, and the research student, who might be of immense commercial value to the community. There is on the other hand the workman, the artificer, the foreman, whose skill the community requires. More and more we must think of his education. If we had a large department of Ceramics, we might be able to establish short courses for him in the interval until a trade school was established under the auspices of the Technical School, and such a trade school as this should before long have a place in our community. It is one of the steps that is necessary for the development of our workers. I hope, therefore, that we may look forward to having in the near future a full equipment for the education of the worker in clays, whether he be a director or engineer in charge, or the intelligent foreman and high-class artificer who will take pleasure in understanding his work and producing the best possible results.

---

[*] A discussion of an editorial article published under this caption on p. 87 Contract Record, Dec. 10, 1913.

[*] Professor of Physics, Ontario Agricultural College, Guelph, Ont.

[†] Of the Geological Survey.

Yours sincerely,
R. A. Falconer,
(President).

Mr. John M. Bowman's Objections

Mr. John M. Bowman, manager of the Don Valley Brick Works, asked for an expression of opinion as to the desirability of establishing a course of Ceramics in Toronto's new technical school, said that he was not in favor of the project. Such a course as that suggested for the technical school could not be of much practical use for future clayworkers. Only by coming in contact with the specific clays with which a man was to be identified could he acquire any really useful knowledge of the successful handling of clays. Mr. Bowman instanced the case of a clayworker of more than twenty years' practical experience who had only within recent years acquired a thorough understanding of the clay bank he was operating. His own experience was that students emerging from such a course in Ceramics had been absolute failures when faced with actual manufacturing problems. A man might be thoroughly successful in the handling of one kind of clay but a total failure with another—an argument which led Mr. Bowman to believe that attempts at burning clays of various kinds in the technical school would lead to nothing but confusion. The only possible way by which a man could learn brickmaking thoroughly was to take up actual work in a yard where the manufacture of miscellaneous brick was carried on. Then he would learn to familiarize himself with the properties of the various clays in use.

The Successful Tenderers for Vancouver's Thirty-Million-Dollar Contract

By our London Correspondent

IT was announced recently in these columns that the firm of Messrs. J. G. White & Company, Limited, electrical, mechanical and civil engineers and engineering contractors, of London and New York, had secured a contract to the tune of some $30,000,000 for a scheme of harbor extension in Vancouver—where certain foreshore rights have been granted to the Vancouver Harbour & Dock Extension Company—and we have thought that some particulars of the firm and of the work they have executed in all parts of the world would not be devoid of interest to our readers.

The company was incorporated in London on July 10, 1900, and was registered to carry on a general contracting and constructional engineering business. The share capital of the company is £200,000 divided into 150,000 preference shares of £1 each, and 50,000 ordinary shares of £1 each, and it may be noted in passing that for the last two years the dividends declared have been 12 per cent. on the preference shares (the maximum to which they are entitled) and 12 per cent., with a bonus of 10s. per share, on the ordinary shares. The American business was originally formed as a private firm in 1890, but owing to the expansion of the work it was reorganized in 1903 as a Connecticut corporation with increased capital amounting now, we are informed, to some $3,500,000. The two companies, although separately constituted and entirely distinct organisations, are in intimate and constant touch, resulting in a working basis of material advantage to both. It is unnecessary to enter into the details of this working arrangement, and it will suffice to say that the London firm carries out and controls any works presented to either of the companies in any part of the world except the North American Continent and the possessions of the United States. The works executed by the associated companies cover a very wide field of engineering enterprise and include electric tramways; steam and electric railways; water, harbour, irrigation and drainage works; water power developments; gas lighting, electric light and power, and industrial plants; electric transmission and distribution systems; and constructional engineering works of wide variety. The directors of the London company are J. G. White, chairman, Lord Arthur Butler, A. N. Connett, W. C. Burton and J. B. White. So much by way of preliminary.

That combination of scientific and business enterprise known as the engineer-contractor, although regarded with little favor by members of professional engineering bodies, is a necessity of modern life. The specialist knowledge of the engineer is of the highest importance and ranks first in any scheme, but the translation of this knowledge—as set forth by pen and pencil—into actuality requires equal knowledge in other directions, in constructional methods for example, in business management and control, and last, but by no means least, in finance. A glance at the components of the huge organisation under consideration will serve to carry conviction on this point. The work of the company falls naturally under five heads: design, contracting and constructional engineering, management, commercial engineering and reporting, and finance. The first three speak for themselves, but on the remainder a few words may be said. As regards commercial engineering and reporting, the company has correspondents and agencies in various parts of the world, and its commercial engineers are in touch with both its construction and management departments, and are ready to examine into and report upon any enterprise, whether existent, in embryo or fully launched. As to finance, the company have brought to them so many enterprises whose financial status requires adjustment, extension or assistance that they have organized a separate department for this phase of their work.

The Cost Insured Contract

The engineer-contractor system has necessarily, as has everything else of a sublunary nature, its drawbacks. To place the whole of an undertaking in the hands of, so to speak, one man, without effective supervision or control, might spell disaster. In the case of a firm of but mediocre reputation, for example, or of one insufficiently supplied with capital or without effective organization, considerable risk might be run were they allowed to work their own sweet will. To the Associated Companies no objection of this nature can apply; none the less they are to be congratulated on the type of contract which they themselves prefer—one arranged on the basis of actual cost and a fixed fee, with a bonus or penalty, as the case may be, if the estimated sum is reduced or exceeded. Under their contract any excess or reduction is divided in agreed proportion between employer and contractor, whereby the interests of the two are identical. On the one hand, a profit is ensured for the contractor, while on the other the employer obtains the best of work at a minimum of cost.

An Interesting Itinerary

It would be impossible within the space of a single article to deal at all fully with the enterprises undertaken by the Associated Companies. A tour of inspection to cover the more important of these completed or now in progress, would, we are assured, necessitate a journey round the globe and travelling more than 50,000 miles. Such a tour would require about two years, although the average distance between works of interest carried out would be less than 250 miles. The following succinct notes have been furnished to us by a correspondent:

"After inspecting a considerable length of tramways in the Metropolis, the Midlands and Scotland would be visited, followed by a trip to Belfast, where the largest tramway contract ever given in Great Britain was executed. Proceeding thence to Holland, the Amsterdam-Haarlem Electric Railway would be found worthy of study. Then through France (the Lille Tramways) to India, where the tramways and lighting plant at Bombay would claim attention. In Australia there are tramways at Perth and North Melbourne, and a large electric light and power plant at Kalgoorlie to be seen, and in New Zealand, the fine tramway system of Auckland.

"Crossing to the Philippine Islands the work of J. G. White & Company, Incorporated, would be taken up, and a prolonged stay would be necessary in order to see in all parts of the archipelago the steam railways and harbour works (on various Islands), the electric tramways and lighting of Manila, and the new United States Naval Coaling Station at Olongapo. Taking steamer to San Francisco, numerous undertakings would claim attention in the United States, in Canada and Mexico, including many large water power developments as far separated as California and Maine, and important irrigation works at various places. A trip would also have to be taken to Port Rico and Cuba.

"The study of the contracts of J. G. White & Company, Limited, would be resumed at Cordoba, in the Argentine, and proceeding thence to Buenos Ayres, the Buenos Ayres Central Railway and the extensive system of the Lacroze Electric Tramways would be visited, and, across the River Plate, the important tramways of Montevideo.

"Passing up the coast to Para, after a call at Santos, the visitor would not fail to be struck by the excellent system of tramways and lighting in that city, the extensive drainage works and the new telephone system. Still there would be a journey of nearly 1,000 miles up the mighty Amazon to Manaos, where he would again find a complete system of electric tramways and lighting. Finally, in the extreme north of the South American Continent, the tour would terminate with an inspection of the tramways of Caracas."

Personal Mention

Mr. Allan D. Hazen, the New York consulting engineer who designed the Toronto filtration plant and who has reported for other Canadian cities, was a visitor to Toronto last week.

Mr. Joseph W. Moulding, of the Thomas Moulding Brick Company, Chicago, was elected President of the American Face Brick Association at the second annual meeting of that body held last month at French Lick Springs, Ind.

The gross value of the estate of the late Mr. John Breckenridge, the well-known railway contractor, who died in Calgary last May, is sworn at $349,843, the net value being sworn at $248,017. More than half the estate is inherited by his wife.

Municipal Engineers

Mr H. Talbot-Crosbie, Yorkton, Sask.

YORKTON'S Town Engineer, Mr. H. Talbot-Crosbie, was born at Ardfert Abbey, Ireland, and educated at the Albany Academy in Glasgow. His father is Mr. L. B. Talbot-Crosbie, late of the Royal Navy and at present Deputy-Lieutenant of County Kerry, Ireland. Mr. Talbot-Crosbie made his first connection with engineering as an apprentice with Messrs. Johnstone & Rankine, civil and mining engineers, Glasgow. The period of his apprenticeship extended from 1894 to 1899. During this time he attended classes at the Glasgow University and Technical College. Upon the completion of his pupilage he became associated with the firm of Kyle, Dennison & Frew, Glasgow, proceeding to South Africa in 1900 but returning the following year to take charge of construction on the Invergarry and Fort Augustus Railway, Invernesshire, Scotland. Mr. Talbot-Crosbie came to Canada in 1902 and soon made connections with Messrs. Mackenzie & Mann by whom he was sent to Nova Scotia on the construction of the Halifax and South-Western Railway. In 1904 Mr. Talbot-Crosbie formed a contract—this time a matrimonial one—and desiring a more settled occupation went west and purchased a farm three miles from Yorkton. In the fall of 1911 Mr. F. McArthur resigned his position as town engineer of Yorkton to become resident sanitary engineer for the province and Mr. Talbot-Crosbie was offered the local appointment, which he accepted. He has the entire charge of engineering works at Yorkton where the present projects include a new water supply from York Lake, four miles distant. Yorkton has not yet attained metropolitan dimensions but it is considered a progressive town with a future. It has a population of 5,200 and boasts of 8.3 miles of water mains, 8.6 miles of sewers and .17 miles of sidewalk. Mr. Talbot-Crosbie is an Associate Member of the Canadian Society of Civil Engineers.

Mr. H. Talbot-Crosbie,
Town Engineer of Yorkton, Sask.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

By a small majority the residents of Montreal west have passed a by-law authorizing the issue of bonds for $275,000.

Preston property owners have decided in favor of utilizing Trinidad asphaltic concrete paving for the streets as against an alternative suggestion in favor of wood blocks. A long standing controversy has thus reached the settlement stage.

To make way for a modern five-storey warehouse at the southeast corner of King and Frederick streets, the old structure which housed the first bank in Toronto is soon to be pulled down. This ancient building, once the quarters of the Bank of Upper Canada, has stood the test of time for almost a century.

The contention of Mr. Currie, city engineer of Ottawa, that the creosote block for paving purposes is not suitable for our climate would seem to be borne out by the reported failure of these blocks which formed the cover of the new Bank street bridge in that city, and which are stated to have buckled badly as a result of the frost.

The legal department has registered a complaint that the building by-laws of Toronto are being disregarded by certain builders in the city. The complaint had its origin in the recent prosecution of a builder for erecting an apartment house, the rooms of which are alleged to be smaller than the by-law allows,

It is stated that the breakwater being constructed by Sir John Jackson, Canada, Limited, will cost at least $1,750,000, and that the two piers for which tenders were invited recently, will represent an immediate outlay of over $500,000. An appropriation of that amount has already been made by Parliament for the work.

Mr. T. H. Jones, city engineer of Brantford, reported at the last city council meeting that five hundred and twenty building permits had been issued during the year, representing a total value of $1,008,731. This is the largest amount in the history of the city excepting last year, when this total was exceeded by about $150,000.

Mr. G. Janin, chief engineer of Montreal, states that during the last year approximately twenty miles of paving were laid. This comprised 50,000 square yards of granite blocks, 180,000 of asphalt, 70,000 of artificial blocks, and other material. The record of 1912 was twelve miles of street pavements, in addition to which the city spent nearly a million dollars on new sidewalks. The mileage of streets paved was the largest on record.

Recently the Controllers of Montreal refused to allow a retiring pension of two-thirds of his salary to Mr. G. Janin, chief engineer of the city, on the ground that to increase the ordinary allowance would establish a bad precedent. Mr. J. L. Perron, K.C., has now introduced a motion into the Quebec Legislature amending the Montreal Bill and making it compulsory for the city to pay the higher pension. Mr. Janin has no intention of retiring at present.

Building permits for Toronto fell off some three hundred thousand dollars in November last, as compared with the same month in 1912, but the permits for the eleven months of 1913 ending November 30 are still ahead of those taken out in the corresponding period of 1912 as indicated by the total of $25,589,856 against $25,465,076 for the previous year. These figures indicate that Toronto is bearing up well under the adverse financial conditions that have lessened activity elsewhere.

According to the estimate of Mr. Chausse, building inspector, the total value of building permits issued for Greater Montreal in 1913 totalled nearly forty million dollars. During the same period the buildings erected in Outremont, Westmount, Verdun, Maisonneuve, and other outlying parts forming Greater Montreal totalled about twenty-five millions, the value of the permits issued in December, 1913, being $1,191,282, as compared with $685,675 in the same period the previous year.

Next spring will see the inauguration of several important public enterprises in Toronto, involving much building and a huge expenditure on bricks and mortar. The Dominion Government will construct a new Federal building on the site of the present post office as enlarged, and a customs and railway mail building on Front Street will cost nearly a million dollars, and a modern fireproofed registry office will also be constructed. These enterprises taken in conjunction with the new Union station and other important buildings, including a five thousand dollar storage warehouse for the Canadian Pacific Railway being erected at King & Simcoe streets, is estimated to make the public building programme for this year embrace an outlay of eight to ten million dollars.

The new million bushel elevator built for the Canadian Pacific Railway at St. Johns, N.B., is completed and is now in use. Grain conveyors are being constructed on two additional wharves and will be completed by February. The steel frame of the main building of the new sugar refinery has been raised to the full height of ten storeys, and the outer casing of brick is nearly as high, while the enormous chimney has been completed, and other buildings of the group are rapidly going up. The large new armory has been completed, and will be formally opened and occupied by the militia within the next month or two. The large new theatre on King Square, the finest east of Montreal, has been open for some time. The steel frame of the handsome new post office is now being erected, after one of the heaviest pieces of work in preparing a foundation that has been experienced in connection with city buildings for a long time. The street railway company has extended its line to form a circuit of nearly three miles of new track beyond Marsh bridge, and plans have been completed for further extension in the spring. The work of preparing the foundations for the new bridge, said to be the longest spandrel arch bridge in the world, to connect east and west St. John and accommodate both street car and ordinary traffic, is well advanced. The capacity of the big pulp mill near this bridge has been greatly enlarged this year. Three miles from the city, at Coldbrook, an automobile factory has been constructed, and arrangements made for the erection of a large nail and wire factory, while a realty and development company has been providing for water service and streets, and the development of a modern industrial suburb at that place. The work of dredging in the main harbor of St. John has been carried on by a fleet of dredges throughout the year, and Norton Griffiths & Company now have powerful machines dredging the channel into Courtenay Bay, the eastern harbour, where they have also steadily pushed forward the great breakwater which is to protect the basin, and the dry dock which they are to construct. Building operations in the city, including warehouses, handsome new bank building and alterations and improvements of two others, new residences and cottages, have been on a large scale, and at the close of the year it was announced that several companies were preparing to go into the erection of new houses this year to be sold on easy terms to persons of moderate income, and located in the outskirts within easy reach, by the street railway extensions, of all parts of the city. The city council has laid during the year a large amount of permanent pavement, and on every side are to be seen marked evidence of progress.

WESTERN CANADA

Among Canadian cities Winnipeg takes third place with nearly $19,000,000 represented in building permits for the past year, while only five cities in the United States show a larger total for the same period.

Writing to the Winnipeg Free Press a correspondent complains of the lack of proper building restrictions in that city. He suggests the appointment by the City Council of a building committee or commission possessing the power to approve or reject all building plans before any progress is made with the proposed work.

Work on the new Parliament Buildings on Broadway Avenue, Winnipeg, is proceeding rapidly, the caisson work being almost completed. Tyndall stone is being used in the building, a feature of which is to be a large dome two hundred feet in height and seventy feet in diameter. The contract price for the building, which will measure 305 feet by 330 feet, is $2,859,750 and the contract calls for completion in 1917.

The directors of the Edmonton Portland Cement Company have decided to install another kiln at their works at Maryboro', located on the Grand Trunk Railway west of Edmonton. This extension will probably mean an increase of five hundred barrels daily. This company only commenced operations last September and since that time a standing order of one thousand barrels a week have been delivered to the Saskatchewan government.

The large storage dam across the Swift Current River, Sask., capable of supply water for a population of 50,000, was formally opened on December 24 by Mr. J. A. Yager, chairman of the waterworks committee. The dam, which is over eight hundred feet long and twenty-five feet high, was constructed by the Amburse Hydraulic Construction Company of Montreal, under the supervision of Mr. Geo. K. Mackie, town engineer, at an outlay of $100,000. The capacity when filled will be over 100,000,000 gallons.

Hon. Thos. Taylor, Minister of Public Works, has announced that the new west wing of the Parliament Buildings in Victoria, B.C., will be ready for occupation on January 15, the day set for the opening of the legislature. Work on the east wing and the library will not be completed until next July. The two wings which are for the accommodation of the administrative departments are estimated to cost about a million dollars. In connection with them an interesting feature is a group of statuary representing public men who earned fame in the development of the western province.

Members of the Saskatoon Builders' Exchange are said to be opposed to changing the law governing the filing of liens against buildings by contractors. By an amendment now pending in the legislature at Regina the law will be altered so as to place such liens secondary to mortgages. The contractors' view is that if the proposed law were to become effective it would practically drive them out of business, consequently the legislative committee of the Builders' organization has had the matter under consideration and a protest against any change will be made to the provincial government.

A bill entitled the "Saskatchewan Land Surveyors' Act," at present passing through the legislature of that province, provides that power be given the Land Surveyors' Association to acquire and hold real estate not producing at any time an annual income in excess of $5,000. Under the Act by-laws shall be prepared by the executive council and before becoming effective shall be ratified by the association. The examination of candidates for permission to practice as Saskatchewan land surveyors shall be under control of a board of examiners, examinations to be held in Regina in February of each year, but special examinations for permission to practice may be held at any time at the board's discretion on payment of a fee not exceeding fifty dollars. Until the age of twenty-one no person shall practice as a land surveyor in Saskatchewan, and then only when the examinations have been passed and a three year term as an articled student completed within five years. In addition eighteen months of this term must be spent in the field in actual practice and at least twelve months in the province of Saskatchewan.

Canadian Railroad Development

Apropos of the rumor that the Canadian Pacific Railway had the purchase of the Canadian Northern Railway in contemplation, Sir Donald Mann, vice-president of the latter has stated that it is against the law for the company to sell out to the Canadian Pacific Railway, the government having provided against any such purchase in order to prevent the possibility of monopoly.

A case of much interest to Winnipeg is going on in the Exchequer Court, Ottawa, between the Grand Trunk Railway and the Canadian Northern road. It appears the former have a right of way through St. Boniface to the Canadian Northern Railway bridge over the Red River, and the Canadian Northern Railway claims $2,500,000 for the property used by the Grand Trunk, part of which belongs to the railway builders personally and part to the railway company. The Grand Trunk's offer is said to be far below the amount claimed, hence the present proceedings.

Hon. Frank Cochrane, Minister of Railways, has signed the agreements which will enable the commencement of work on the important terminal undertakings plant for the city of Quebec. They involve a division between the Transcontinental and Grand Trunk Railway (as lessees of the Canadian Pacific Railway) of millions of dollars of expenditure necessary for the construction of the new Union station and the tunnel to give access to it, as well as the settlement of all matters concerning the construction of the station for the Transcontinental Railway at Champlain Market, and the construction of car shops at St. Malo covering a site of about two hundred acres. The new Union station on the Palais site promises to be one of the finest of its kind in Canada and is to be connected with the St. Lawrence waterfront by a tunnel which will provide not only for the entrance of the National Transcontinental but also for other railways re-

Messrs. J. H. Tromanhauser, of Toronto, and Raoul de B. Corriveau, (District Engineer, Department of Public Works), Ottawa, are both mentioned as candidates for the office of Second Vice-President of the American Society of Engineering Contractors. The election of officers will take place at the annual meeting which is to be held in New York on January 16.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 January 14, 1914 **No. 2**

Principal Contents

Engineering Responsibilities and Lay Administration.. 29
The Toronto Filtration Plant 29
Letters to the Editor 31-33
Mr. Allen Hazen on the Toronto Filtration Plant.
Mr. W. H. Freeborn on Educational Facilities for the Clayworker.
Methods and Results of Water-Works Test for the City of St. Boniface, Man. 34-35
By G. L. Redmond, Winnipeg.
The Decorative Possibilities of Concrete 36-45
By C. W. Boynton and J. H. Libberton.

The first part of a copious extract of an interesting treatise prepared for the Western Society of Engineers. The complementary portion will appear in the Contract Record for January 21. The subject, despite the title, is discussed in such a way as to appeal particularly to those of practical rather than of aesthetic temperament, constructional methods and the use of material being emphasized throughout. The article in its entirety is illustrated by fifty half-tone illustrations.

To Set Out Spirals by Offsets from Long Chord 46-48
By E. S. M. Lovelace.
Organizing and Executing the Construction of a Reinforced Concrete Industrial Building, Part 1 49-51
By Leonard C. Wason.
General Methods of Repairs and Renewals in Road Work 51-52
By A. W. Dean
The Provincial Courthouse Addition, Vancouver 52
Canada's First Reinforced Concrete Church 53
Vancouver and Coast Correspondence 54-57
Constructional News 58-59

The Toronto Filtration Plant

ELSEWHERE in this issue Mr. Allen Hazen, the well-known consulting engineer of New York, makes a spirited defence of the efficiency of the Toronto filtration plant from the standpoint of design, construction and operation. The letter contributed by Mr. Hazen should not be allowed to pass unnoticed and unanswered, for whatever differences of opinion there may be it is certain that the author of the letter is desirous of making a straightforward explanation illustrated by only such purely technical data as are required to make his points. The letter is addressed to the Editor of the Contract Record, but it concerns every public-minded Toronto citizen in general and everyone identified with municipal engineering design and construction in particular.

Some of Mr. Hazen's observations appeal to us very strongly. Particular stress must be laid upon the limited sum placed at the disposal of the engineers. It is like measuring a rapidly-growing boy for a skin-tight suit. By the time he gets it, it is useless. The development of Toronto has gone on by leaps and bounds during the last few years and we are inclined to think that it is the city, not Mr. Hazen, that is to blame for the installation of a plant half the size required for immediate expansion. Mr. Hazen is surely right in assuming that no filtration plant ever provoked greater criticism. This, taken in conjunction with what Mr. Hazen shows in his table, namely, that the Toronto plant is the cheapest—in regard to its capacity—ever built, would seem to suggest an illuminating discussion.

In our last issue the increased consumption of water following filtration was the subject of an article based upon the experience of Toronto, whose consumption of water increased between the years 1908 and 1912 from 30,00,000 to 44,700,000 Imperial gallons. A careful reading of that article in conjunction with the material published in this issue may be found instructive.

Engineering Responsibilities and Lay Administration

MONTREAL'S unfortunate experience with its conduit, a break in which deprived the city of its water supply for a whole week, brings up the question of whether such things are not the direct result of the administration of the city's affairs by politicians who are hampered by having their own and other individual ends to serve. This is an issue worthy of close concentration—an issue which pops up whenever a municipality makes a mess of things. The worst of it is that, collectively, we seem quite unable to learn a single lesson. Every now and then we wax indignant about some atrocious blunder on the part of a municipality, but in the end things simmer down, the man in the street forgets the sensation and the private interest inside the local corportion prevails.

In defence of the governing authorities at Montreal it is held that they were responsible only in an indirect sense, that is to say, because they placed the seal of approval upon an incomplete plan and allowed the engineering department to proceed without building an emergency conduit. But the day has passed when responsibility can be evaded on such grounds.

We contend that a system which gives final authority in engineering matters to ill-informed politicians is fundamentally wrong. Constituted as things are at present, the engineer of a municipality is only a servant taking instructions. He may lack in ability and experience, but that is not the issue: his competency, or incompetency, is the concern of those who retain his services. On the face of it, it would appear to be lacking in balance to retain a man alleged to be incompetent for a number of years and suddenly discover that he is not "big enough" for the position. Had he been "big enough" for the appointment in the first place he would have developed with the municipality and none better than he would have been qualified to plan for its future growth. Before generalizing further, however, it may be of interest to enter into a few details about the collapse of the conduit.[*]

Revealed by an investigation made by Professor Brown, of McGill University, the state of affairs at Montreal was deplorable. Professor Brown states that the aqueduct, which is now being considerably widened, had been enlarged until the sides were so close to the conduit that, on one side, only a few feet of loose earth supported the structure. In addition, the aqueduct had been excavated to a depth of several feet below the bottom of the conduit. It was intended that the conduit should be imbedded in earth, providing it with lateral supports on both sides. On one side, however, this support had been practically removed several hundred feet, while the foundations were in danger of being undermined by the deepening of the aqueduct. The conduit was subjected to forces which had not been reckoned with and cracks developed on the aqueduct side. After some ineffective patchwork had been attempted, a fissure, sixty feet long, developed, and a large portion of the side broke away, causing the complete stoppage of the city's pumps. Professor Brown criticises severely the methods employed in the repair of the conduit, the inefficiency of which was responsible for much needless delay. Finally he affirms that cracks are still likely to occur in several hundred feet of the conduit upon which the greater portion of Montreal depends for its water supply. Professor Brown's observations are confirmed in the main by Mr. Phelps Johnson, vice-president and general manager of the Dominion Bridge Company, and ruling president of the Canadian Society of Civil Engineers, who, however, adds that the repairs have been carried out expeditiously and capably and are permanent.

Particularly in relation to engineering works the present system of election and subsequent administration is a most lamentable one. In Montreal, Toronto and other large cities throughout the Dominion, we are carrying through constructional works the execution of which calls for great business acumen and technical skill; and yet, with an expenditure of millions involved, a very considerable part of the administrative end is relegated to men of remote origin whose principal asset, nine times out of ten, is an inflated idea of their own worth.

Is it not time that we took warning from such developments as those at Montreal and considered the need for a thorough investigation of our system of government? So-called official enquiries into local blunders are all very well in season, but why not an investigation higher up? Why is it that the candidates for our municipal offices are drawn from the tag-rag of the business world? How is it that it is impossible to induce the substantial men of the community to run for office? How many men who are taking an active part in the administration of our affairs—at Montreal and Toronto, for instance—are capable on the ground of technical or business training, general information—and even elementary education, of taking any intelligent, constructive part in the discussion of an important engineering enterprise?

We believe that all these questions could be answered and solved by a centralized administration—government by a few competent men demanding the highest salaries paid in any field. In Montreal it has been suggested that the control of engineering, financial, industrial and commercial undertakings be handled by a body of, say, three men, appointed for at least six years, retiring in rotation and receiving a salary of not less than $20,000 a year. We are inclined strongly in favor of this suggestion, feeling confident that had such a plan been put into effect in recent years it would have meant a saving of hundreds of thousands of dollars in both Montreal and Toronto. Of course there are objections to government by commission, but we fail to see how these could be sustained in face of the hopeless muddle in just one department—water supply—for which the present system has been responsible at the above cities, and at Ottawa in addition. To our mind the most difficult thing is to find men worth the large salaries suggested. If they were not available in our own country it might be undesirable to have the control of the greater part of our important municipal affairs in alien hands. But in any case it would appear timely to inaugurate a public movement with a view to educating the community to an appreciation of its responsibility in the matter of maintaining and supporting the present system.

From the information at hand it is possible to arrive at no other conclusion than that there has been either gross neglect or out-and-out incompetency at Montreal. In the interest of both municipal engineering and municipal administration it is to be hoped that the apathy of the man in the street, which is usually in evidence within a month of such an occurrence, will not find its way into the promised investigation, the outcome of which will be awaited with interest.

Fighting oil fires with sawdust was discussed at a meeting of the American Society of Mechanical Engineers by Mr. Edward A. Barrier. The efficiency of the sawdust, he said, was undoubtedly due to its blanketing action in floating upon the surface of the liquid and thus excluding the oxygen of the air. Its efficiency was greater on viscous liquids than on thin liquids. Sawdust itself was not easily ignited and when it did become ignited it burned without flame and the burning embers did not have sufficiently high temperature to reignite the liquid. It was found that the addition of sodium bicarbonate greatly increased the efficiency of sawdust, as shown both by the short time and by the decreased amount of material necessary to extinguish fires. A further advantage of the addition of bicarbonate of soda was that it decreased the possible danger resulting from the presence of sawdust in manufacturing plants.

---

[*] The conduit is 9 x 7½ ft., of horseshoe shape, laid on a grade of about 1:5000, with crown 4 to 5 ft. below ground surface. It carries water under a slight head (hydraulic grade 5 to 10 ft. above top of pipe). It was designed in the office of the Water Department and was built by Patrick McGovern, of Boston, Mass. Its section may be described as follows: Invert: Radius, 13 ft.; thickness, 8 in. Sides and arch: Inner face a part-circle of 4½-ft. radius, and so placed as to give a clear height of crown above invert 7 ft. 8½ in.; outer face, such as to give thickness at crown 8 in., thickness at base of sides 8 in., and thickness on horizontal centre about 12 in. Reinforcement: Clinton wire mesh.

LETTERS

The Toronto Filtration Plant

New York, Jan. 7, 1914.

Editor Contract Record:

It is now two years since the filter plant on Toronto Island was put into service. Probably no water purification plant ever built has been subject to a greater amount of criticism. For the most part this criticism has been unjust and unwarranted. The plant was designed by our firm under Mr. C. H. Rust, then City Engineer, and Mr. Longley, now one of our partners, acted as Resident Engineer for its construction. As the city is now proposing to build another plant of different character, against our advice, after we had been engaged to design an extension of the present plant, a brief statement in regard to the old plant—what it is, what it is capable of doing, and what it has cost—may be in order.

The Plant a Substantial and Ample One

The construction throughout is simple and substantial. Concrete masonry in arches designed to be in compression throughout forms most of the structure. All the piping and auxiliaries are of ample capacity to serve the intended rate of output, and are also sufficient to carry a fair percentage of overload. These matters are all described in a paper presented recently by Mr. F. F. Longley to the Canadian Society of Civil Engineers and printed in their transactions.

The main part of the work was constructed under contract by the firm of Dill, Russel & Chambers. The pipe and specials were furnished by the Canada Foundry Company; gates, by the Ludlow Valve Company and the Coffin Valve Company, while pumps and other equipment were furnished by the John Inglis Company and the Allis-Chalmers Company. All of the work was performed in a workman-like manner under close inspection. It compares favorably with corresponding work in any plant and reflects credit on the several contractors.

The Capacity of the Plant

There is some misapprehension as to the capacity of the plant. In a water-works pumping station, as a general rule pumps must be at hand with a capacity twice as great as the average daily output. There are two reasons for this. One is that the rate of output fluctuates and that the pumps must operate at times at a higher rate than the average; the other is that pumps must be put out of service for overhauling and repair from time to time, and the station must be capable of yielding full service with one or more units idle. The same is true of all kinds of water-works equipment but in varying degrees.

With filters it is a common rule that the capacity of the plant must be 50 per cent. greater than the average daily output. This rule applies equally to sand and mechanical filters. A filter is a more reliable piece of apparatus than a pump and the filtering capacity does not have to be as great as the pumping capacity to insure reasonable safety.

The present plant was designed to have a nominal capacity of 48 million gallons a day, suitable at the above-mentioned ratio for an average daily output of 32 million gallons a day. It was designed when the average rate of output was 28 million gallons a day, and was increasing but slowly. The rapid growth of the city, and the still more rapid increase in the amount of water required per capita after the plant was started brought the consumption above its intended capacity before it was put into service. It is passing a daily average of nearly 40 million gallons of water at the present time. It would be possible to force it to pass a larger quantity but at some sacrifice in quality. On the other hand, if no more water was demanded from it than the amount for which it was designed, the average quality of the output at the present time would be appreciably improved. The remainder of the present supply is not filtered but is disinfected before use.

Plant an Economical One in First Cost

The appropriation under which the plant was built was limited. The sum of $750,000 was provided to built a 40-million-gallon plant. Instructions were given that the cost must be kept within the appropriation. As this size would clearly have been too small, an effort was made to design a larger plant that could be built within the estimate. Actually a 48-million-gallon plant was built at a cost slightly above the appropriation. Thanks to favorable natural conditions the Toronto plant is the cheapest plant for its capacity of any large plant ever built.

In the following table are given for a number of large plants the approximate cost and capacities and costs per million gallons of daily capacity. These figures include engineering and contingencies and all necessary auxiliary structures, but do not include land. The capacities and costs per unit are given both in U. S. and Imperial gallons. The unfortunate difference in size of the gallon in the United States and

COST OF RECENT LARGE WATER PURIFICATION PLANTS.

Plant	Kind	Approx. Cost including Engineering and Contingencies but excluding land	Nominal Capacity		Cost per Million U. S. Gallons Daily Capacity	Cost per Million Imperial Gallons Daily Capacity
			Millions of U. S. Gallons per day	Millions of Imperial Gallons per day		
Toronto	Sand	$757,000	57.5	48.0	$13,200	$15,800
Minneapolis	Mechanical	616,000	39.0	32.5	15,800	19,000
Watertown	Mechanical	100,000	6.0	5.0	16,700	20,000
East Jersey	Mechanical	540,000	32.0	26.6	16,900	20,200
Grand Rapids	Mechanical	350,000	20.0	16.7	17,500	21,000
Columbus	Mechanical	615,000	30.0	25.0	20,500	24,500
Harrisburg	Mechanical	317,000	14.0	11.6	22,600	27,200
Springfield	Sand	343,000	15.0	12.5	22,900	27,500
Toledo	Mechanical	522,000	20.0	16.7	26,100	31,400
Kansas City, Kan.	Mechanical	175,000	6.25	5.2	28,000	33,500
Cincinnati	Mechanical	3,344,000	112.0	93.0	30,000	36,000
Albany	Sand	500,000	16.0	13.3	31,300	37,500
Washington	Sand	2,736,000	81.0	67.5	33,800	40,500
New Orleans	Mechanical	1,354,000	40.0	33.3	34,000	40,500

in Canada has been the source of much confusion. The difference is great enough so that it must be taken into account, and failure to do this has led to some misunderstanding in the past.

Accurate cost data for the sand filter plants at Philadelphia and Pittsburgh, and for the mechanical filter plant at Louisville, are not at hand. None of these costs was particularly low, and if the figures were available they would not be found at the low end of the table. Large water purification plants in Europe have usually cost more per unit of capacity than American plants.

Any comparison like that made in the table is at best incomplete because local conditions of many kinds cannot be adequately taken into account in a short table.

The fact stands out that the present sand filter plant at Toronto has cost less than any plant of its size that has ever been built. It has not only cost less than other sand filter plants, but it has also cost less than any mechanical filter plant of corresponding capacity. This is due primarily to the favorable local conditions existing upon the Island for the construction of sand filters. It would not be possible to build a corresponding plant of adequate service at the same price under less favorable conditions.

Plant Economical in Operation

An estimate was made of the probable cost of operating the sand filters before the plant was put in service. This amounted to $1.83 per million Imperial gallons ($1.52 per million U. S. gallons). This is exclusive of the cost of low lift pumping. Experience with the plant during the past two years has shown that this estimate was ample, the actual cost being somewhat below this figure.

In comparison with this the corresponding estimate of cost of operating a mechanical filter plant, exclusive of low lift pumping, is $4.80 per million Imperial gallons ($4 per million U. S. gallons). The sand filters are cheaper to operat by $3 per million Imperial gallons. Assuming that the plant is operated at an average of two-thirds of its rated capacity year in and year out (the present plant has been doing much more than this) the saving in operating expenses amounts to $96 per day, $35,000 per annum, equal to 5 per cent. interest on an investment of $700,000. This amount is nearly equal to the first cost of the present plant. It follows that the whole cost of filtering would be no greater with sand filters than with mechanical, even though the first cost of the sand plant were nearly doubled. In other words, a reserve area of 100 per cent. could be provided, or a corresponding investment made in settling basins and other works for preliminary treatment, if that were needed, and still the filtered water could be delivered as cheaply as it could be done by means of mechanical filters.

Effect of Turbidity

It has been alleged that sand filters are unreliable for filtering lake water because at times of storms the lake water is stirred up and the water applied to the filters becomes turbid or muddy. This condition tends to increase the difficulty of conducting the operation of purification. This is true of any kind of plant that could be used. One of the reasons why it is possible to filter Lake Ontario water so cheaply is because the water, as a rule, is not subject to much turbidity. During the two years that the plant has been in service, turbid water has been experienced. At times the turbidity has been greater than shown by any record of preceding years. Much of the time, also, the rates of filtration have been excessive, because the plant is not now large enough for the city's needs. Notwithstanding this, the filters have operated successfully and have produced at all times water free from turbidity and well purified bacterially.

Quality of Effluent

No means of filtration has yet been devised capable of producing more perfect and regular purification than sand filters, where the water to be treated is susceptible to this form of treatment. General experience in this respect has been borne out fully by the results at Toronto. The efficiencies, especially after the irregularities of the first months of operation were past, have been as high as could have been anticipated, and as high as could be secured by any treatment that could be used.

Leakage From the Plant

About a year ago announcement was made in a most conspicuous way that the Toronto filter plant was defective, and that a considerable part of the water applied to it was lost by leakage. Investigation promptly showed the cause of the apparent discrepancy. The water passes through a meter before going to the filters and again upon leaving them. The meter at the inlet indicated 8 or 10 per cent. more than the meters at the discharge. The meter at the inlet was out of adjustment. The control apparatus placed beside it for the express purpose of permitting the detection of this kind of error had not been used. Apparently the superintendent of the plant did not understand its use. Bringing it into use promptly disclosed the error. When the meter was adjusted the difference disappeared.

There is, of course, some leakage from the filters, as there must be from all plants of this kind, but the leakage is not greater than is to be normally expected, and no harm results from it.

Conclusion

I hope I have made it clear, in the first place, that the Toronto plant is an exceptionally economical one from the standpoint of first cost; in the second place, that it is exceptionally economical to operate; and in the third place, that it is producing water of excellent quality, equal to that which could be produced by any system. The plant, although not elaborately finished with architectural and other auxiliaries that might appropriately have been part of a more costly plant, is substantial and adequate at every point, and capable of rendering the best of service up to the extent of its intended capacity.

Yours truly,

Allen Hazen.

Educational Facilities for the Clayworker

Editor Contract Record:

I have read with much interest your trenchant article, "Educational Facilities for the Clayworker," published in your issue of December 10 and think that you deserve credit for the able manner in which you have presented the question. It is certainly a most opportune time to bring forward the matter of better educational facilities for the rising generation and it is gratifying to note the announcement in your last issue that a department will be established in the new technical school at Toronto.

As you say, the technical school is calculated to promote particularly the interests of men especially adapted for certain practical work. We must not overlook the other side of the question, however. Unless further steps be taken, what chance have our sons to go through the University and not be lost to the industry? There seems to be no reason why a boy should not remain in the industry and be placed on a level with other professions. Is there not a certain amount of humiliation in the reflection that if our sons decide upon a course in ceramics they have to go to a foreign country? It is sad but true that the authorities of our province have made provision for every department in the constructional field except clayworking. The clay industry will not recover quickly from this neglect. The average employee—of the brick plant for example—does not measure up to the average employee in other lines of industry. The right kind of workmen, with both muscle and brain power, is fast disappearing and it has been a source of great anxiety to the employer. Is not this state of affairs attributable directly to the low standard and status of the industry—unattractive remuneration, poor prospects, and last, but not least, inadequate educational facilities?

It is an excellent move to provide a course in the new technical school at Toronto, but judging from reports one can only conclude that it will be a purely local enterprise, redounding chiefly to the advantage of Toronto brickmakers, and it is a matter of some regret that the Ontario Legislature could not make this a government undertaking and amend the educational system so as to make provision for establishing a chair of ceramics in the University. Long ago the government of the United States awoke to a sense of their responsibilities in this regard, and, as a result, several cities in the Union are able to offer clayworkers an up-to-date University course. We lay claim to having one of the best educational systems in the world, but such a distinction is far removed from us. As to the value of such a course, no substantial objections can be brought forward. Professor Bleininger, a well-known authority whose word is recognized by the Canadian trade, says: "Technical education will not make a man better intrinsically, but it will make him look into the chemical actions and re-actions which take place and it will fit him to conduct his observations from both a scientific and a practical viewpoint." Mr. Richardson, of Columbus, Ohio, says: "I wish to give all possible encouragement to the movement in favor of starting ceramic schools. This is an enterprise which would amply repay all expense and help to develop the clay industries of the country."

Canada possesses within its bounds all the materials required to meet the requirements of the home market, but we cannot expect to make proper use of these materials without an adequate technical knowledge of how to work them. With a continued lack of such knowledge, foreign importations must necessarily increase. We are unable to meet the demand owing to inadequate manufacturing facilities, which, in turn, are due to insufficient information. The development of our clays and shales is of greater importance than that of any other minerals for the reason that they are identified so closely with our social needs and because they open up so many avenues for the employment of home labor.

Yours truly,

W. H. Freeborn.*

Are Canadian Clayworkers in Second Place?

Interviewed by the Contract Record in regard to educational facilities for the clayworker, a subject which has been exercising the minds of some of our readers lately, a prominent Toronto building supply firm made some rather caustic comments. The opinion was expressed that in this section of the country, at least, brick manufacturers, generally, were not desirous of taking any active part in a movement for educational facilities. Until the present season they had had so much demand for their common brick that there had been no reason to make any other product to increase their business. They could make enough profit on common bricks to pay them well, and although the profit on face brick of the better quality was proportionately greater, it involved different machinery, much more care in handling and the carrying of a considerable stock of different shades and qualities. As showing the subtleties practised in some quarters, one manufacturer was cited as having made a more or less successful attempt at making a high class of face brick from practically the same clay from which his pressed brick were made—simply giving them a little more heat in the kiln. The profit in this case was very considerable. Clayworking achievements on the other side of the border, it was contended, were greatly ahead of our own from the standpoint of cost.

Montreal's Good Building Record

The features of building operations in Montreal during the past year was the increase in the average cost of structures. The permits were 3,974, of a total value of $27,032,097, as compared with 3,791 permits and $19,408,690 in 1912, the increase thus being $7,623,407, while the permits only gained three. The following shows the values month by month of the new buildings only: January, $341,475; February, $454,562;; March, $656,705; April, $3,063,259; May, $2,138,128; June, $2,031,975; July, $1,349,000; August, $1,951,697; September, $1,738,670; October, $4,462,650; November, $3,695,706; December, $1,260,980.

The issue of permits for three structures valued at over $1,000,000 each, helped materially to swell the total, although the buildings are not yet completed, while the erection of ten large office buildings was also an important factor in this connection. There is evidence, however, that the demand for this class of accommodation has been fully met for the time being, and the present year will probably see a falling off in the skyscraper description of structures. Montreal has been building at a great rate, and the value of the permits has been steadily rising for a number of years. In 1900 it was $3,089,400; ten years later it rose to $15,715,859, and the 1913 figures show a gain over this of more than $12,000,000. Nor does this adequately represent the position, for the figures of Maisonneuve, Westmount and Verdun, forming part of Montreal, are not included, owing to the fact that these places have separate municipal government.

On the whole 1913 was a good building year. Supplies were more plentiful than in 1912, when there was almost a famine in bricks, and when there was also a shortage in other materials. At present there is no indication of any ambitious plans for the current year, but there should be plenty of work in the way of houses and flats, for which there is an increasing demand, and which is not nearly being met. It is difficult to secure this class of property, many houses being rented before they are three-quarters finished.

With the restoration of Montreal's water supply, the demand for an investigation into civic administration, particularly of the water and engineering departments, has been strongly insisted on. A committee of citizens have retained Mr. John R. Freeman, president of the American Society of Mechanical Engineers in 1905 and consulting engineer of the New York Board of Water Supply, to make an independent report, and the Controllers state they will place any data they have at his disposal. Mr. J. E. Jamieson, Mr. R. S. Lee, and other engineers have made an inspection of the conduit and the aqueduct and reported on the situation. The Controllers have decided to construct a second conduit from the intake, and to do this it will be necessary to get power from the Quebec Legislature. The Controllers have further received authority from the Federal Government to connect the pumping station with the Lachine canal by means of a conduit, to be used in case of emergency. It has also been decided to make a connection with the Montreal Water & Power Company's system.

Messrs. T. Pringle & Sons, Ltd., the Montreal firm of engineers, have established in St. John a branch office for the Maritime Provinces. They say that business houses in the upper provinces have neglected good opportunities of which prompt advantage has been taken by American concerns.

---

* Past President Canadian National Clay Products Association.

Methods and Results of Waterworks Test for the City of St. Boniface, Man.

Contributed by G. L. Redmond, Winnipeg.

THE water supply of the city of St. Boniface, Man., is drawn from wells by means of a recently installed air lift pumping plant and stored in an underground reservoir. This latter is connected to the working sump by a pipe line which is controlled by a valve and may be opened or closed at will. The bottom level of the sump is below the reservoir so that the reservoir may be easily drained off in this way. The capacity of the sump is 1,005 gallons per foot of depth.

The test referred to was conducted for the city of St. Boniface in August, 1913, by E. Brydone-Jack, Consulting Engineer, of Winnipeg, in order to determine: (1) the capacity of the wells; (2) the efficiency of the pumping plant.

Tests were made on each well to determine, where possible,* (1) operating conditions; (2) the approximate discharge of water by weir measurement; (3) air consumption at the wells.

TABLE 1—DIMENSIONS AND CAPACITIES OF WELLS AS FOUND BY TEST

Shallow Wells

Number of Well	1	2	3	4	5	6	9	10
Capacity Imp. gallons per min.						40.7	33.5	38.8
Depth of well below prairie level	59′ 0″	60′ 2″	60′ 10″	59′ 9″	53′ 6″	79′ 0″	91′ 11″	92′ 1″
Static head from prairie level	40′ 6″	40′ 2″	40′ 3″	39′ 9″		40′ 4″	39′ 4″	39′ 2″
Pumping head from prairie level	43′ 3″	54′ 3″	44′ 0″	43′ 8″	51′ 6″	45′ 3″	40′ 11″	43′ 2″
Total lift	34′ 9″	44′ 11″	36′ 6″	33′ 11″	41′ 8″	35′ 7″	40′ 3″	42′ 0″
Depth of submergence	13′ 10″	4′ 7″	13′ 10″	16′ 1″	0′ 0″	19′ 6″	31′ 0″	25′ 4″
Percentage of submergence under running conditions	28.3	9.3	27.4	32.2	0.0	35.4	43.5	38.8
Size of discharge pipe	2″	2″	2″	2″	2″	2½″	2½″	2½″
Depth from pump to bottom of well	1′ 10″	1′ 3″	3′ 0″	0′ 1″	2′ 0″	14′ 3″	20′ 0″	23′ 8″

Deep Wells

Number of Well	11	12	13
Capacity Imp. gallons per min.	79.2	66.4	305.4
Depth of well below prairie level	350′	350′	350′
Static head from prairie level	38′ 11″	39′ 6″	39′ 3″
Pumping head from prairie level	303′ 8″	323′ 10″	109′ 0″
Total lift	302′ 5″	322′ 1″	107′ 9″
Depth of submergence	31′ 8″	13′ 10″	232′ 4″
Percentage of submergence under running conditions	9.4	4.1	68.3
Size of discharge pipe	4½″	4½″	4½″

1. Operating Conditions

The readings taken under this heading were tabulated for purposes of comparison, thus:

2. Weir Readings

The shallow wells were piped directly to the sump into a 10 ft. x 12 in. weir channel with 60 deg. notch. In order to secure an even flow an ordinary baffle plate was introduced at the upper end of the channel and the hook gauge 4 ft. above the crest of the weir. The readings for the deep wells were taken at the reservoir in a 10 ft. x 18 in. channel with 60 deg. notch, except in the case of well No. 13, where a rectangular form of weir was used.

Certain preliminary observations were noted in each case before beginning the actual test, viz., size of channel; length of channel; size of weir; distance of hook gauge above crest; temperature of water; zero head (i.e., height of water above zero on gauge at starting). Readings were then taken by means of the hook gauge every minute for a period of from half an hour to an hour on the different wells, the results being tabulated as taken, thus:—

Time	Reading
4:00	.724
01	.733
02	.757
etc.	etc.

From the observed readings the true readings were found by subtracting the zero head at starting.

The first readings, of course, showed a gradual rise in rate of discharge, while the final readings showed a corresponding decrease, the method used in compiling results being to take a section of the observed readings showing the maximum uniform flow, determine the true readings for this section and find the average reading.

The final results showing rate of delivery at wells were expressed in British Imperial gallons per 24 hours. These results appear in Table No. 2.

3. Air Consumption at Wells

The preliminary observations taken in this case were: size of orifice; static head; depth from discharge to pump. The actual readings were taken simultaneously with the weir readings at intervals of two to five minutes, the readings being taken for: pressure by gauge; temperature of air; height of water column (referring to a particular style of air meter supplied by the firm installing the compressors).

Final results showing air consumption at the wells were expressed in cubic feet of free air per minute. These, in conjunction with the weir readings, as shown in Table No. 2, give the number of cubic feet of free air per gallon of water pumped.

Test on Machinery

The air lift pumping plant consists of:

Two cross-compound air, motor driven air compressors, each driven by a 100 h.p., 550-volt, 3-phase, 60-cycle, 720 r.p.m., slip-ring type motor with external resistance for alternating current, complete with resistance starter, necessary switchboard, switches, meters, transformers, connections and frames.

---

* Wells 1-5 (averaging 60 ft. in depth) were not subjected to test 2 and 3 owing to insufficiency of water in the wells. Wells 7 and 8 were not connected. The remaining shallow wells, 6, 9 and 10, ranging in depth from 79 ft. to 92 ft., and the three deep wells, 11, 12 and 13 (360 ft. below prairie level), were subjected to all three tests.

Average prairie level equals El. 100.

One cross-compound air, simple duplex steam, steam driven air compressor.

One 42-in. x 10-ft. vertical air receiver, complete with pop and safety valves and gate valve on discharge.

Wells 1-5 are equipped with No. 4 Harris pumps; wells 6, 9 and 10, with No. 5 Harris pumps; and wells 11, 12 and 13, with No. 9 Harris pumps.

Capacity Test

In order to determine the constants of the apparatus used, a preliminary test was made under the headings: Pitot tube; intercooler; receiver.

1. Pitot Tube

Formula:

$$V = 18.3\sqrt{\frac{h}{w \times a}} \text{ ft. per sec.}$$

Q = quantity of air in cubic feet.
h = inches of water.
w = air density lbs./cu. ft.

Preliminary Record:

Barometer reading (Aneroid).
Temperature of air inlet.
Section of air inlet.

Differential Pitot tube formula $Q = 183 \sqrt{h}$ cu. ft. per min. Readings h and Q were then taken every half minute for five minutes.

2. Intercooler

$$\text{Formula: } M = \frac{w\,(t_2 - t_1)}{s\,(T_1 - T_2)}$$

M = weight of air passing through intercooler lbs./min.
w = weight of cooling water " " "
t_1 = inlet temperature of water degrees Fahr.
t_2 = outlet temperature of water degrees Fahr.
T_1 = inlet temperature of air degrees Fahr.
T_2 = outlet temperature of air degrees Fahr.
s = specific heat of air.

$$M = \frac{260}{.071} \text{ x cu. ft. water x } \frac{\text{diff. water temp.}}{\text{diff. air temp.}} \text{ cu. ft. per min.}$$

3. Receiver

$$\text{Formula: } \frac{P \times v}{T}$$

P = lbs. per sq. ft.
v = cu. ft. of air per lb.
T = absolute temperature.

The following readings were taken every minute for five minutes: receiver pressure; receiver temperature; receiver contents; flow of air cu. ft./min.

Orifice Test

This test consisted of pumping the air into the receiver and then discharging it through the orifices directly to the atmosphere, so as to keep a constant pressure in the receiver. Only one compressor was tested in this way at one time, thus making it possible to ascertain the amount of air being pumped by same. Simultaneously the indicator cards were taken as well as the electrical readings, Pitot tube readings, intercooler readings and cooling water readings. The Pitot tube and intercoolor readings differed from those of the preliminary test only in being more extended. Certain readings were taken on the electrical motors of compressors 1 and 2 simply in order to arrive at the efficiency and horsepower at pulley. The orifice readings on all three compressors were taken with orifices open ¼-in. and ½-in. diameter, the direction of flow being horizontal. From these readings, with the help of tables, was calculated the quantity of free air in cu. ft./min. at 91 lbs.

The figures given below are the average results of the various tests for mechanical efficiency:

Electrical Compressors

Compressor No.	No. 1	No. 2
Electrical consumption in kw at receiver pressure 91 lbs.	72.0	74.5
at receiver pressure 100 lbs.	76.3	78.0
Horse-power consumption at receiver pressure 100 lbs., electrical efficiency, including belt, 89 per cent.	91.0	93.0
Mechanical efficiency	94.3%	90.65%
Volumetric efficiency	94.7%	95.3 %
Compression efficiency	*	*
Intercooler (difference of water temp. intake and outlet)	27° F.	21.8° F.
Quantity of air	470 cu. ft.	473 cu. ft.

Steam Compressor

	(3)
Indicated h.p. of steam cylinders at receiver pressure 91 lbs.	90
at receiver pressure 100 lbs.	95.5
Mechanical efficiency	92.8%
Volumetric efficiency	95.2%
Compression efficiency	*
Intercooler (difference of water temp. intake and outlet)	22.5° F.
Quantity of air	475 cu. ft.

*Approximately 90 per cent., slightly lower than the guarantee carried by the compressors, for elevation at Winnipeg, but would satisfy the guarantee at sea level.

TABLE 2—RATE OF DELIVERY AT WELLS

Well No.	Well, Standing		Well, Pumping		Well, Rate of Delivery			Air Consumption at Wells				Cu. ft. free
	Depth ft.	Static hd. ft.	Subm'g'ce ft.	Pumping hd. ft.	Cu. ft. per sec.	Cu. ft. per min.	Gals. per 24 hrs.	Gauge, Pressure	Temperature	Cu. ft. per min. Compres'd	Free air	Air per gal. of water.
1	48.58	32.00	13.8	34.78	Unable to make test due to insufficient water in well.							
2	49.50	30.83	4.6	44.90								
3	50.33	32.75	13.8	36.53								
4	50.00	30.00	16.10	33.90								
5	41.66	.25	.00	41.66								
6	55.08	30.75	19.50	35.58	.1089	6.534	58,700	12.875	70.0 F.	27.76	52.0	1.27
7							Not connected.					
8							Not connected.					
9	71.25	38.75	31.05	40.20	.0896	5.376	48,300	18.00	62.0	22.36	49.5	1.47
10	67.33	38.00	25.30	42.03	.1038	6.230	56,000	17.50	60.0	26.03	57.0	1.46
11	334.00	38.00	31.62	302.40	.2117	12.702	114,100	67.25	71.8	44.64	248.86	3.14
12	335.92	37.75	13.80	322.12	.1774	10.644	95,600	74.60	56.0	47.05	285.6	4.30
13	340.00	38.00	232.30	107.7	.8312	49.872	448,000	108.25	61.0	18.3	153.0	0.491

The Decorative Possibilities of Concrete[*]

By C. W. Boynton and J. H. Libberton

IN the early days of construction, the architect and engineer appeared on the work under the title of master-mason. This individual wore long robes as an indication of his authority, and the designs on his trestle board are a matter of history. With the passing of the master-mason came the architect and engineer, the one a worker in lines, and the other a worker in figures.

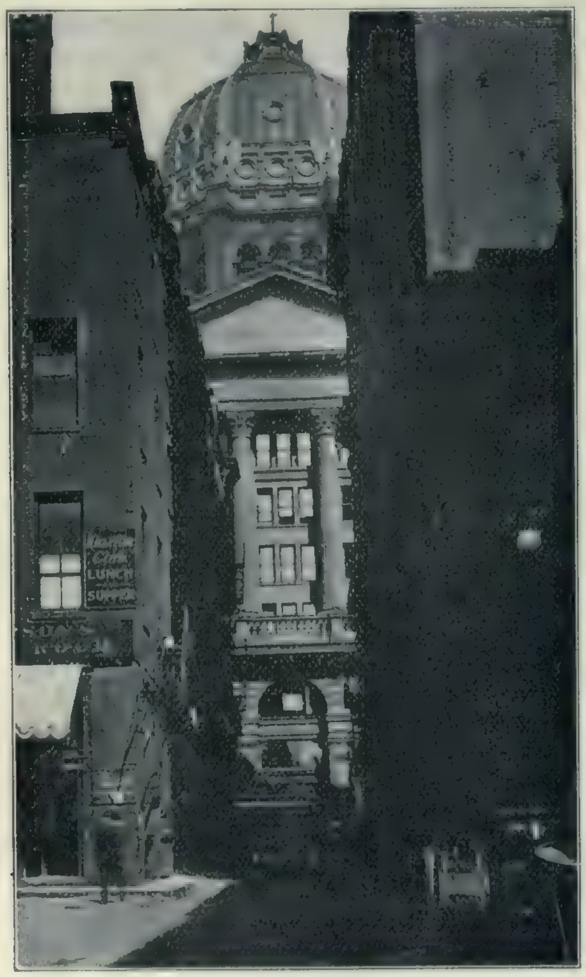


Fig. 1.—Chicago Post Office. West Front.

The combination is ideal; one specializing on beauty and the other, safety and efficiency. Too often, however, safety and efficiency receive first consideration, and the beauty only gets its share after costs have been carefully calculated.

In reality, the most common buildings of a manufacturing type can be made to conform to pleasing lines without the additional expenditure sometimes thought necessary. After pleasing lines have been determined, then comes the question of decoration. In many instances this is carried to extremes and we find exquisite examples of stone carving and cornice work being placed at the top of an eighteen or twenty-storey office building, which no one can see or appreciate except a possible few located in the offices upon the opposite side of the street.

This may be said of the Chicago Post Office (Fig. 1), with the exception that here the entire structure has been judiciously placed. It is well recognized that a structure of this kind occupies a maximum ground area with a minimum return in floor space and light area. This building was a large undertaking from an engineering standpoint, but whether or not it is an architectural success, few may judge because of the impossibility of viewing the entire building at one time. Of the same type is the Capitol at Washington, but so judiciously has it been placed that a full view may be obtained from all sides without obstruction. In the open, or upon the crest of a hill, the Chicago Post Office, even though inefficient in design, would be architecturally beautiful.

There is an old maxim to the effect that the designer should ornament his construction and not construct his ornamentation. This is an admirable saying, but it should be subordinated to another rule: that he should ornament his structure only if he lacked the skill to make it beautiful in itself. A structure of any kind that is intended to serve a useful end should have the beauty of appropriateness for the purpose it is to serve. It should tell the truth, and if the character

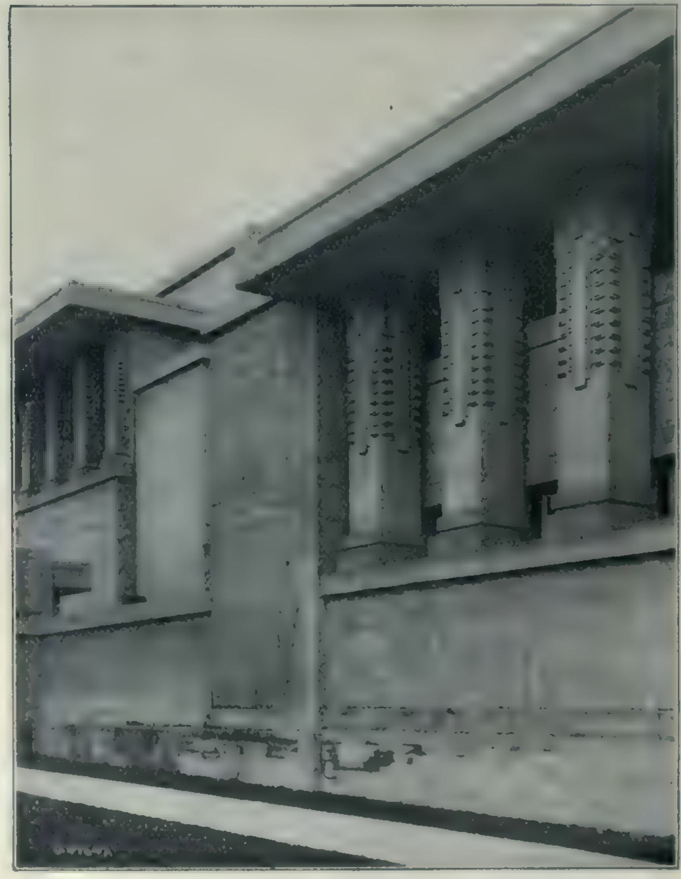


Fig. 2.—Detail of Unity Church, Oak Park, Illinois.

---

[*] In the Journal of the Western Society of Engineers. Published in a slightly abstracted form in The Contract Record by the kind co-operation of the Secretary of the above Society, Mr. J. H. Warder, to whom we are indebted for the illustrations.

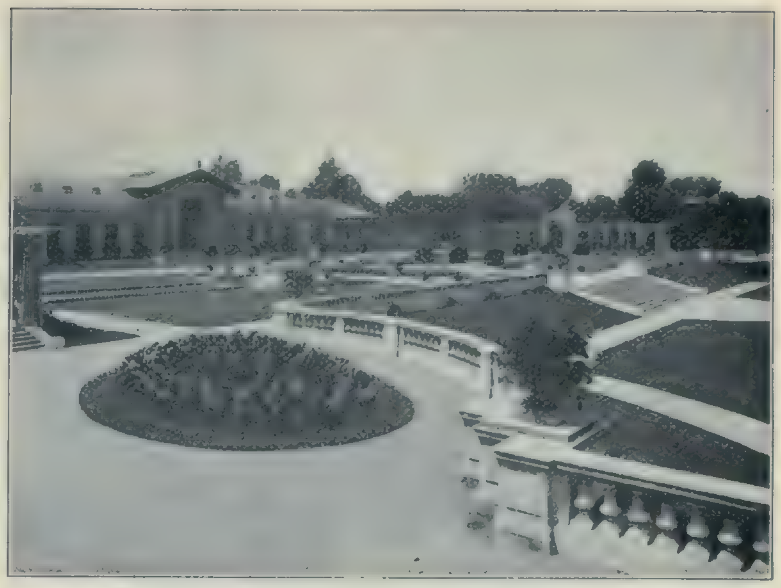


Fig. 3.—Concrete in the Administration Building, and balustrade, Washington Park, Chicago.

were such that it can be permitted to tell the whole truth, so much the better. It should preferably be beautiful and not beautified.

There is a certain charm about a massive structure almost irrespective of design. The sight of a pyramid on the desk would call forth no expression of interest or enthusiasm, but let this grow in size until it assume the proportions of those famous structures of Egypt and many pilgrimages will be made to view it. Of course the Egyptian pyramids are assumed to be the resting-place of kings, and the placing of the blocks required the use of more muscle or machinery than we at present have any knowledge of, but our idea of their beauty and grandeur obtains primarily from the immensity of the structures.

There is no reason, however, why mass should not be combined with decoration, provided the design is not made subordinate to the decoration. This combination has often been used very effectively. The question is, what medium shall be chosen? At the Unity Church, Oak Park (Fig. 2), the building is not only monolithic concrete but the ornamentation partakes of the same characteristics, having been cast at the same time and of the same material. In a building of this type, however, much attempt at decoration would be fatal and the unobtrusive style adopted detracts not in the slightest from the dignity obtained by large areas and massive construction. With a different style of building, such as the Administration Building at Washington Park (Fig. 3), the treatment may be entirely different and the concrete be called on to assume the most intricate shapes.

Both of these buildings show the same surface finish. The architecture determines the decoration. With conditions reversed and the decorations transposed, the effect would be ludicrous. In these buildings the monotony of the form concrete has been relieved by the use of a rather dry surface mixture which discloses the nature of the aggregate used. In work of this kind, particular attention must be paid to methods of obtaining uniformity of surface and absence of horizontal joint markings (Fig. 4), although the latter blemish is not nearly so noticeable on work of this character as with the wet mixture.

After all, the question of pleasing effects depends not only on the surfaces and the surface treatment, but on the combination of design with the surface texture. Compare, for instance, the factory of the Carter's Ink Company with that of the Piqua Hosiery Company (Fig. 5). Both have been finished with the same tools but the former shows infinitely more work without obtaining a pleasing effect. The difference seems to lie mainly in the appreciation of the possibilities in a molded material. A number of large surfaces have been substituted for the cut-up stone effect and the judicious use of the bush hammer has accentuated the massive and graceful design of the building (Fig. 6). And this effect has been achieved without any expensive decoration or form work than would be required for the most simple structure of reinforced concrete. On a smaller building, such as a subway entrance in Boston (Fig. 7), the method of dividing off the panels is more pleasing, possibly because the proportion of small areas to the whole is so much greater. Nevertheless, you will agree that the method of treatment used on the Piqua building is even superior on a small structure, such as the Weston Fire Station (Fig. 8), where also the panels have been bush-hammered, preserving the corners and margins intact. Consistent with its purpose, the entire structure is of rein-

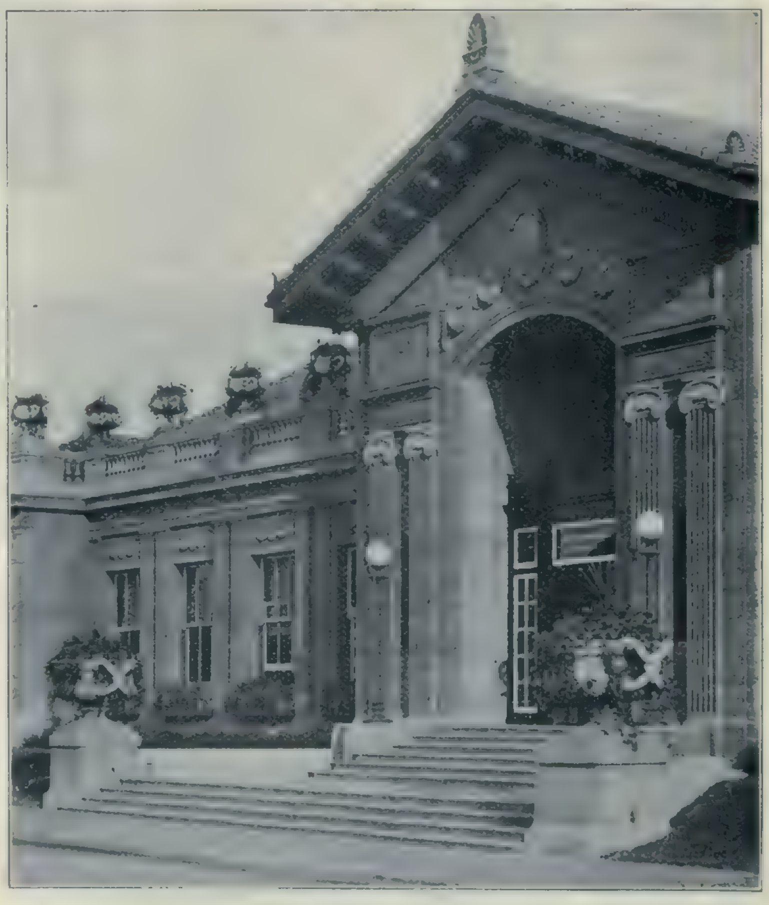


Fig. 4.—Entrance detail. Administration building of the South Park Commissioners, Washington Park, Chicago.

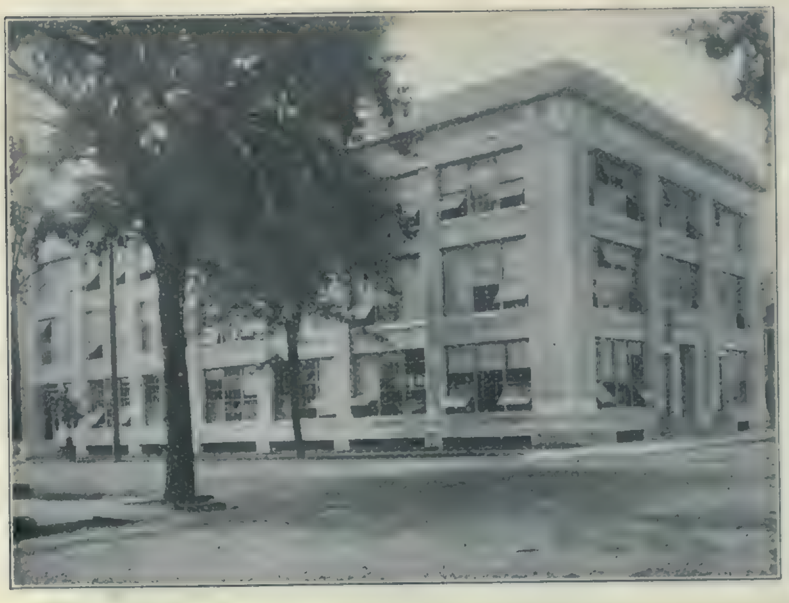


Fig. 5.—Manufacturing building of the Piqua Hosiery Company, Piqua, Ohio.

forced concrete. When not carried to extremes, the judicious use of a few division marks, such as have been employed by the Witherbee Sherman Company in its power station (Fig. 9), relieves the plainness of design and forms a rather interesting framework for what would otherwise be a monotonous surface. Had the block surface been carried across the entire wall, the pleasing effect would have been ruined.

No doubt everyone is familiar with what seems to be the proverbial small town water supply tank, with its hemispherical bottom and sprawling legs—anything but an ornament in the community. This same type of structure was installed at Gary, Indiana (Fig. 10), but so well has it been concealed that the tower is a thing of beauty and possesses real architectural merit. The work of molding so large a structure in reinforced concrete was greater because of the forms required, the total height being 125 ft. But the finished structure justified the labor. The lower 25 ft. and the upper cornice are of cast concrete stone, made by George Rackle & Sons of Cleveland. The remainder is of reinforced concrete. The relief for the surface monotony is seen in the decorative work at the top and base.

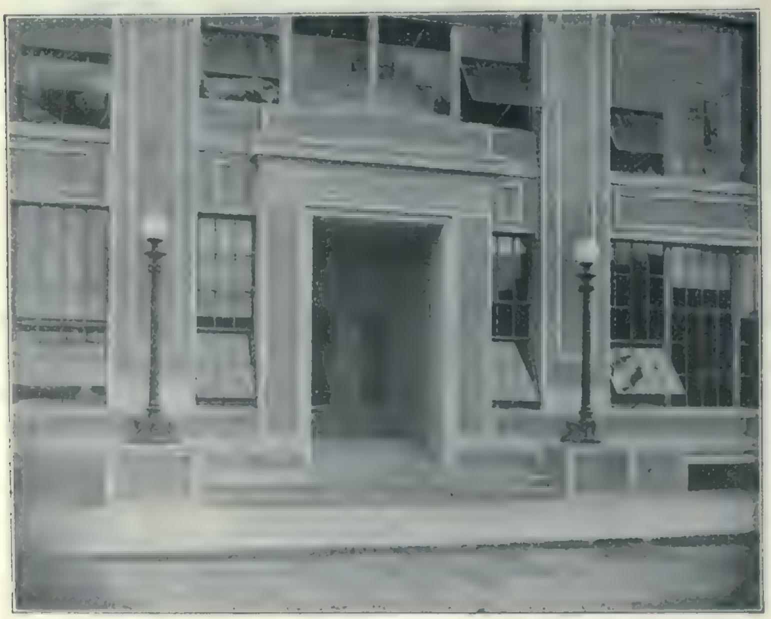


Fig. 6.—Detail of entrance to the building of the Piqua Hosiery Company, Piqua, Ohio.

Decoration, however, is not an essential of construction, as has been clearly demonstrated by the Spanish in the design of the adobe dwellings and missions. But adobe perishes and our interesting relics of former days will soon be a thing of the past. Noting the possibilities of monolithic concrete for preserving this architecture, Frank Miller has undertaken to petrify indefinitely, as it were, some of the most interesting details of the mission architecture developed by the Franciscan Fathers in California (Fig. 11). Thus when the last adobe wall has crumbled we still shall have a replica of the Campanile of San Gabriel (Fig. 12) and the imposing arches of San Fernando, these having been duplicated in the Glenwood Inn at Riverside, California. Little other material than concrete has been employed—except the roof tile, which undoubtedly lend color to the scheme and interest to the picture. On the roof is a famous collection of bells, over 300, dating back to 1278. It seems, consequently, particularly fitting that these old relics, after their furious experiences, may now rest content, enclosed and surrounded by a structural material which will preserve their last resting place intact through the centuries to come.

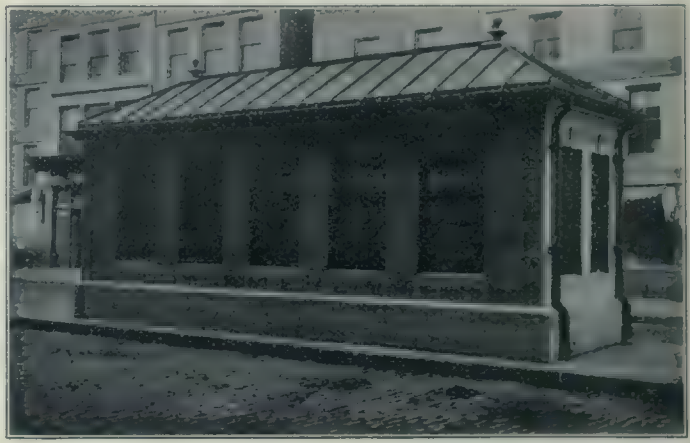


Fig. 7.—Subway entrance, Boston.

Of a mission type, also, are the rest or way stations of the Pacific Electric Railway, at Pasadena, California. These are fast replacing the old wooden rough and ready stations, none of which was consistent with the high class residential district through which the company operated. On both sides, a bench is built into the wall so as always to furnish protection from rain.

An unexpected test of building materials presented itself during the San Francisco earthquake, and the architect for the delightful bell tower on the Mills College campus, Miss Julia Morgan, states that it was one of the few buildings which remained undamaged in that vicinity.

Because it includes some of the most notable sculpture on the coast, the buildings of the

Throop Polytechnic Institute at Los Angeles, Cal., may have interest (Fig. 13). It is all of reinforced concrete, even to the tower, and was designed by Myron Hunt, of Los Angeles. The sculpture was executed in New York and cast in glue molds by a local company, the cost of this one item being something over $5,000. Warm climates seem particularly suited to plain concrete construction, and its general adoption may partially be explained by the cool appearance of the plain surface.

Concrete, still in its formative state of development, is a comparatively new architectural material, although structurally it has been proving its permanence for many years. The particular reason for gratification comes in the new discoveries, and new uses to which it is continually being put. Every day there arises some Philistine who has discovered something new and worthy of consideration.

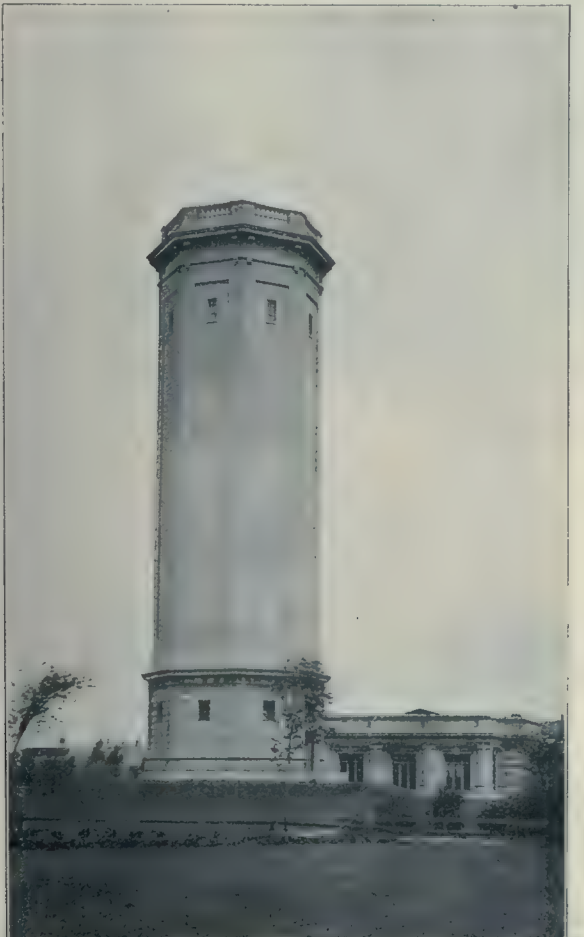


Fig. 10.—Gary water tower, Gary, Indiana.

Frederick Squires, of New York City, had viewed with regret the present slab and beam floor construction. After several years of study, he devised a method of duplicating the most intricate of cast ceilings in solid concrete, with a decided saving of material. His scheme consists simply in employing reverse coffers of moulder's sand (Fig. 14) which are placed on the form before the concrete is poured. When the forms are removed, the panels are exposed, the whole being accomplished in one operation. Far more pleasing surfaces are obtained than were ever presented by the old plaster-of-paris method of applying previously cast panels to the work (Fig. 15).

A few years ago the theory of applying concrete by means of a hose and nozzle met with derision, but every day we hear of more work being done by this method, the machine being designated as the "cement gun" and the concrete "gunite." An interesting piece of work has been accomplished by the Boston Elevated Railroad at the foot of O Street, Boston, where a

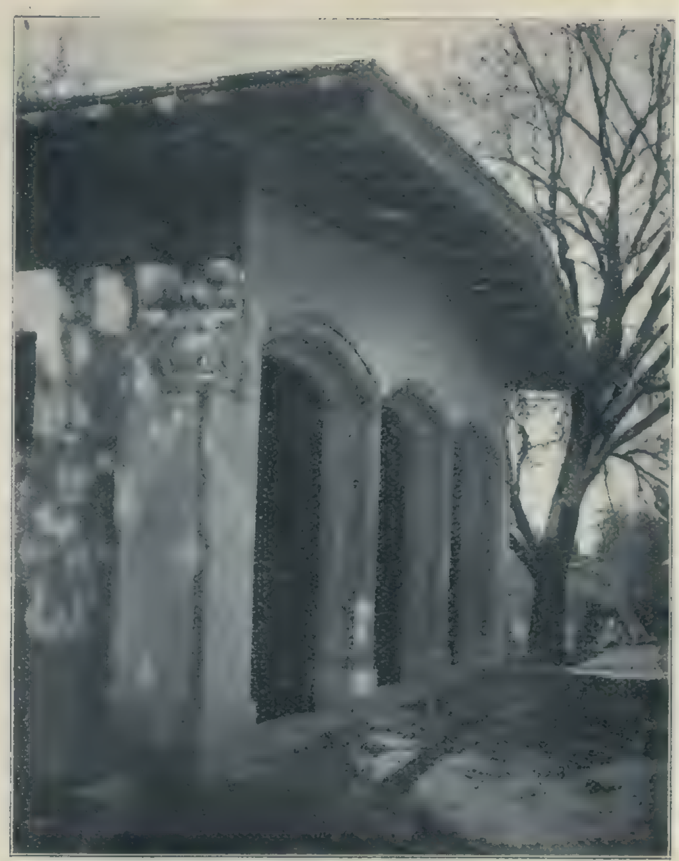


Fig. 8.—Weston fire station, Weston, Mass.

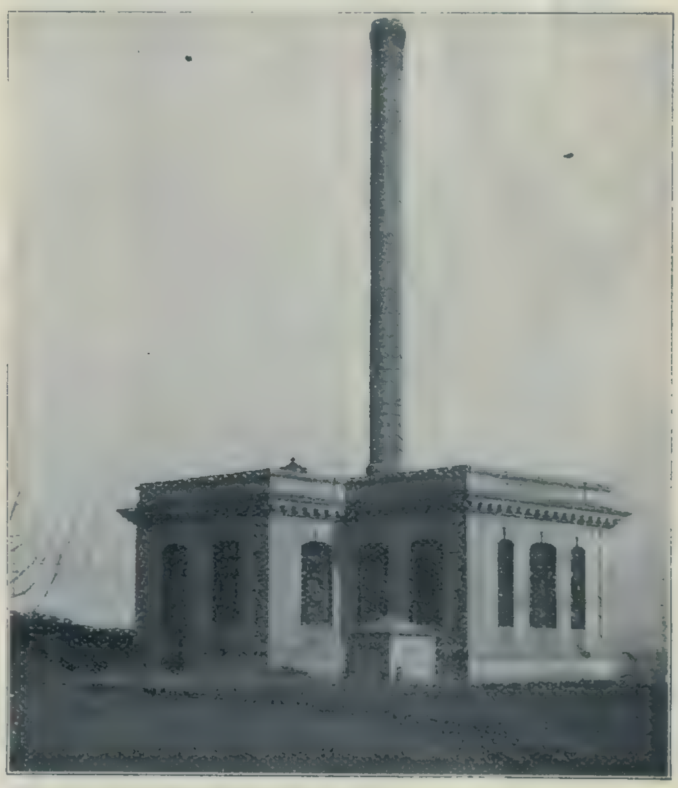


Fig. 9.—Power house, Witherbee Sherman, Port Henry, N.Y.

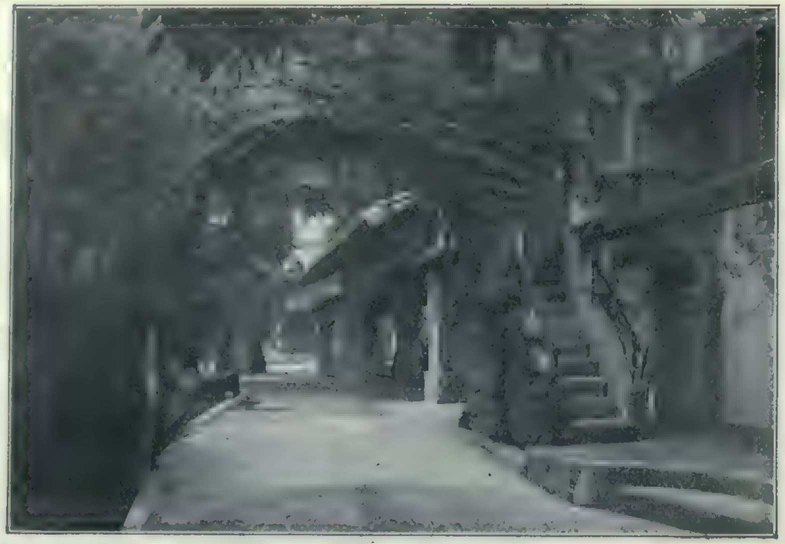


Fig. 11—Court-yard, Glenwood Inn, Riverside, Cal.

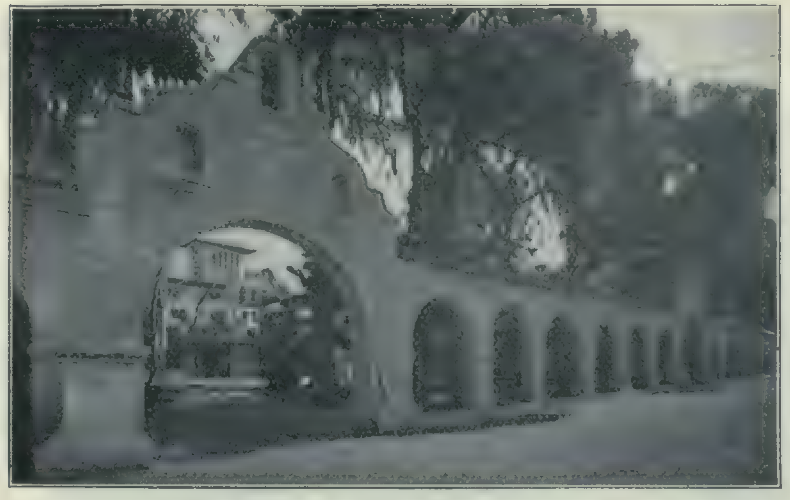


Fig. 12—Glenwood Inn, Riverside, Cal., looking from the street into the court-yard.

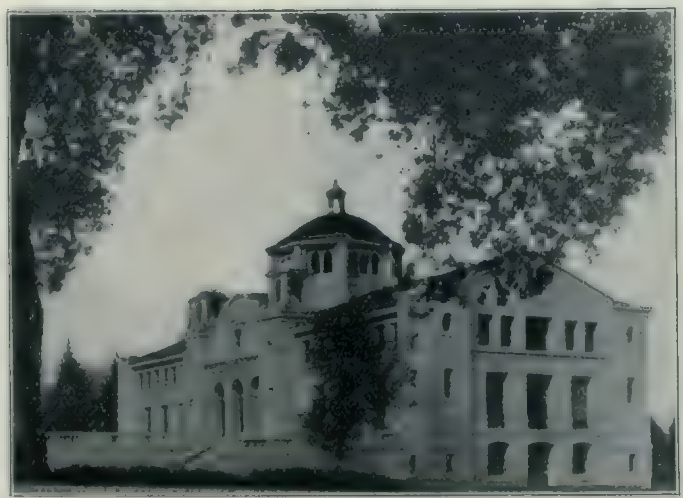


Fig. 13—Throop Polytechnic Institute, Los Angeles, Cal.

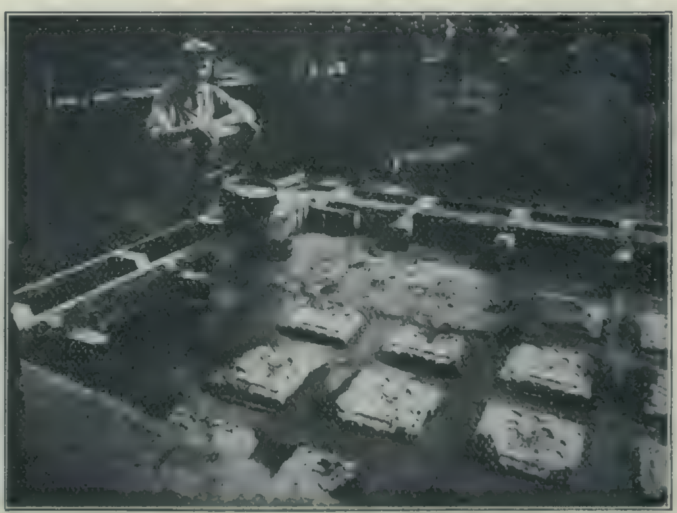


Fig 14—Pouring concrete floor with panel inserts of moulded sand or plaster.

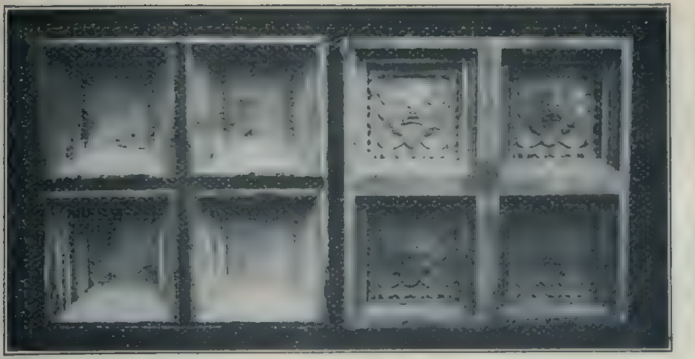


Fig. 15.—Sample of panelled ceiling work done with sand or plaster moulds.

garden fence has been constructed by this method. The base and posts are built of concrete poured into the forms in the usual way, the posts being relieved by protecting brick quoins (Fig. 16). The street face of the panels were shaped by means of a wooden form and each central panel was faced with steel. The concrete was applied from the rear with the cement gun, making the panels 2½ in. thick and the styles 4 in. thick. The interesting point in the operation is that the entire panels are made in one piece and at one operation.

The very fact that concrete is simple in operation has caused many to undertake construction who are in no way fitted to carry it out, but with proper supervision even the most unskilled laborer can accomplish pleasing results. This has been proved conclusively by the work of the Aberthaw Construction Company at Port Antonio, Jamaica (Fig. 17). The fifty-six columns for the structure were cast in sand molds, then put into a lathe and turned down and polished so as to expose the coarse aggregate. An intensely red coloring matter present in the natural aggregate has given the walls a light salmon tint, which is very attractive. Particular attention is directed to the methods of elevating the concrete to the work, and judging from the smiling faces of the women shown in Fig. 18, the task does not seem to be over-tedious. For this hard labor they receive about 25c per day. Able-bodied men on the same work receive about twice this amount. Even with the lack of artistic appreciation which the people of this class possess, the building has been designed so as to be architecturally pleasing and will undoubtedly have its effect in educating the people to a better realization of what constitutes good architecture and design.

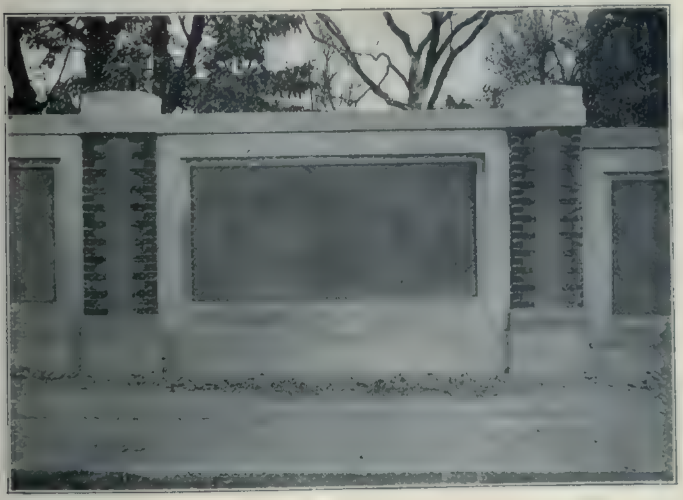


Fig. 16.—Cement gun construction on wall of the Boston Elevated Railway.

A building should be fitted to the country in which it is to be located, and more and more attention is continually being given to the unity which must exist between the landscape and the layout of concrete structures which are to be added as permanent improvements. A striking example of this is to be found on the Duke Estate at Somerville, N.J. (Fig. 19), where white cement and white sand have been used in facing the concrete, in order, possibly, to give more contrast against the natural beauty of the surroundings. The bridge (Fig. 20) harmonizes with the rest of the work but might be improved if the surface markings were eliminated—the general lines eccentuated by bush-hammering, or some one of the other numerous interesting surface treatments, to which concrete may be subjected.

In a similar manner the concrete posts which have been added to the Lake Shore Drive in Chicago, not only add materially to the dignity and beauty of this boulevard but are, themselves, better set off by being so well located (Fig. 21). Imagine this particular design on South Clark and Harrison Streets. For a while the posts would look entirely out of harmony with their surroundings, but there is every probability that their advent would produce a desire on the part of the property owners to clean up the streets and buildings so as better to accord with the dignity of the lamp standards.

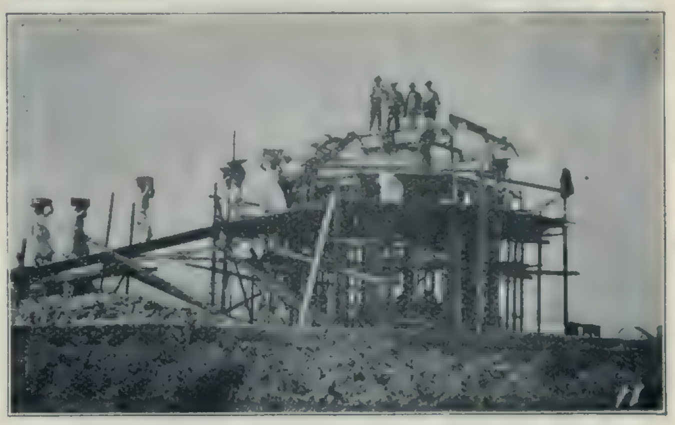


Fig. 17.—Concrete construction in Jamaica, showing the method of elevating concrete.

A note on the method of construction of these poles may be of interest since they are of reinforced concrete, cast in one piece including the base (Fig. 22). The surfacing is made of a special mixture of cement, dark red Wisconsin granite, and a small amount of mica, which is washed, after removing from the mold, with a weak solution of hydrochloric acid. The design is the result of a contest in the Chicago Architectural Club, the successful contestant being John Hamilton.

Of a similar nature is the work on the concrete railing around Jackson Park Harbor, also in Chicago (Fig. 23). Here, as before, the concrete depends for its beauty upon the surroundings rather than upon the excellence of the design, although it is well agreed that little could be added which would improve the dignity and solidity indicated by this superior example of a concrete railing. The white surface is obtained by the use of limestone screenings which emphasizes the important part the aggregate plays in determining the color of the concrete into which it enters.

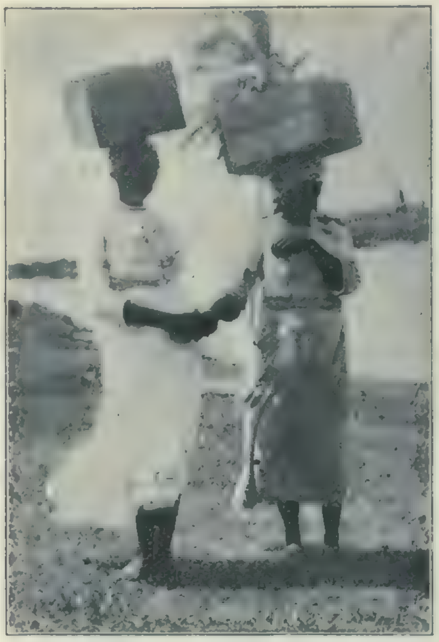


Fig. 18.—Concrete elevators on construction work in Jamaica.

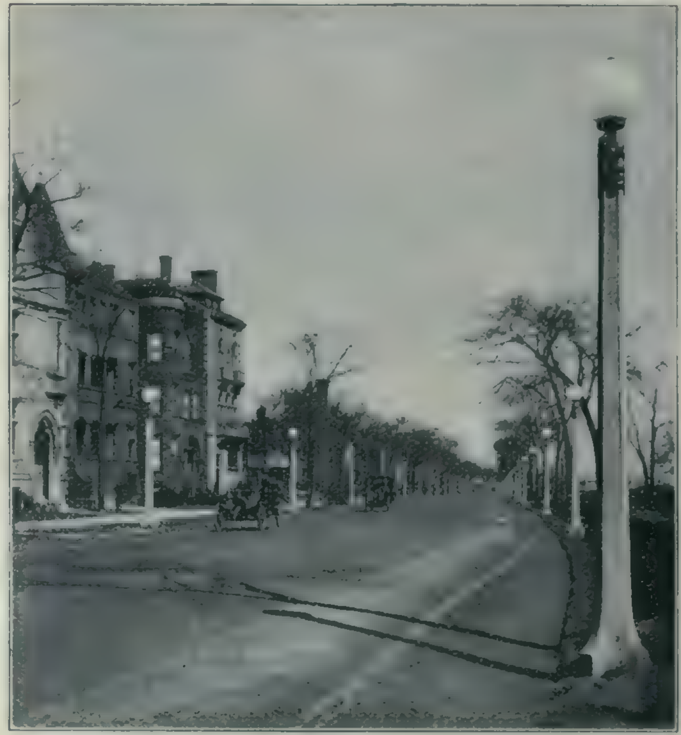


Fig. 21.—Lake Shore Drive, Chicago, with concrete lamp standards.

The attention which is being paid to the design of improvements which will harmonize with the surroundings may well be illustrated by the work of the B. & O. Railroad, on its Independence Boulevard viaduct, Chicago (Fig. 24). A total of some twelve to fifteen different designs were prepared and only after careful consideration was one finally decided upon, which the railroad officials thought would be suitable to submit to the Park Board. How well they succeeded is evident. Were the plain steel structure considered by itself, a realization could be had of the tremendous improvement which has been effected by the simple addition of the reinforced concrete covering. Some of the earlier work of the B. & O. Railroad shows an entirely different method of handling concrete, depending upon inlaid tile for decoration rather than upon the excellence of the design (Fig. 25). Of course, as this bridge is located on West Ogden Avenue, Chicago, there is nothing in the way of beautiful landscape to mention and probably the officials believed that a little brightening of the concrete surface would relieve the monotony of a busy business street. But work of this kind is extremely expensive and can best be illustrated by a comparison of this bridge with the Independence Boulevard structure which is of 250-ft. span.

The Ogden Avenue Viaduct is 135 ft. between abutments, and yet the cost of concrete finish and inlay tile was greater than the total for the other structure of 250-ft. span. A simpler structure has been designed for Sacramento Boulevard (Fig. 26), but as this street is much narrower than Independence Boulevard, naturally an entirely different method of treatment was necessary and the lines have been made to follow somewhat along the Mission style.

Concrete surfacing not only protects the steel, making painting unnecessary, but it improves the general aspect of the structure. This is well illustrated by a very unimposing viaduct in Pittsburgh which recently was found to be rusting away for lack of paint. Feeling that the structure's existence was justified, the

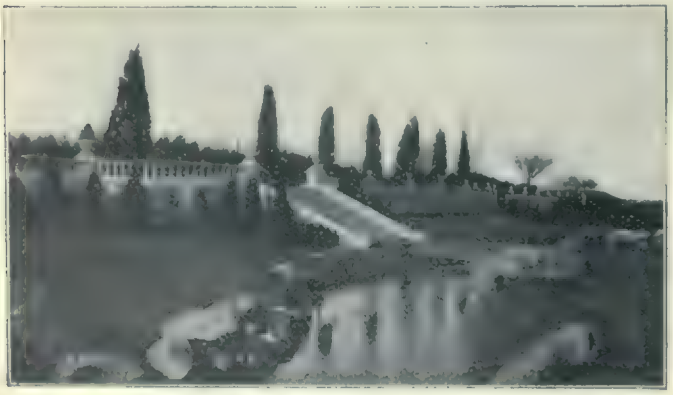


Fig. 19.—Concrete retaining wall and balustrade on Duke Estate, Somerville, N. J.

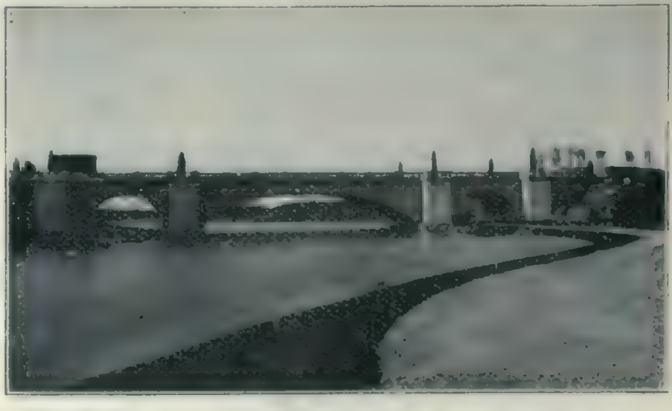


Fig. 20.—Concrete arch bridge on the Duke Estate, Somerville, N. J.

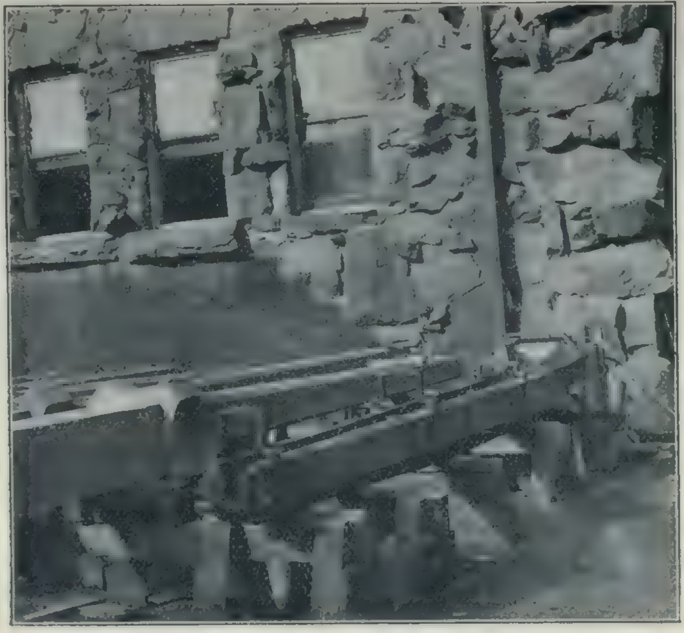


Fig. 22—Steel moulds for casting concrete poles.

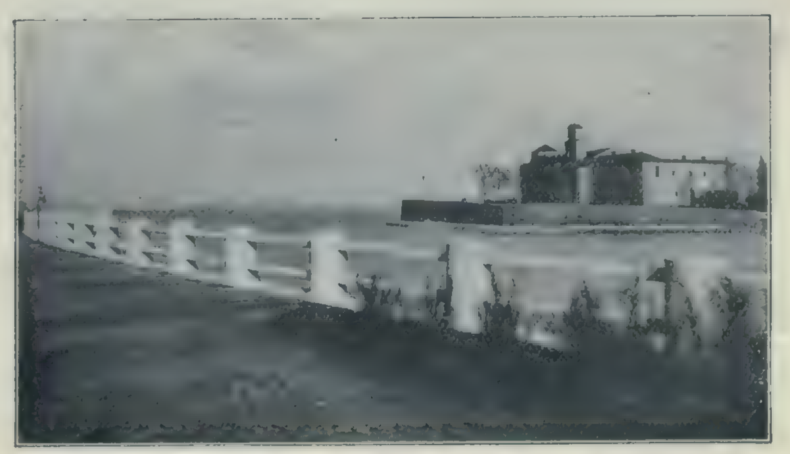


Fig. 23—Concrete railing around entrance to Jackson Park Harbor, Chicago.

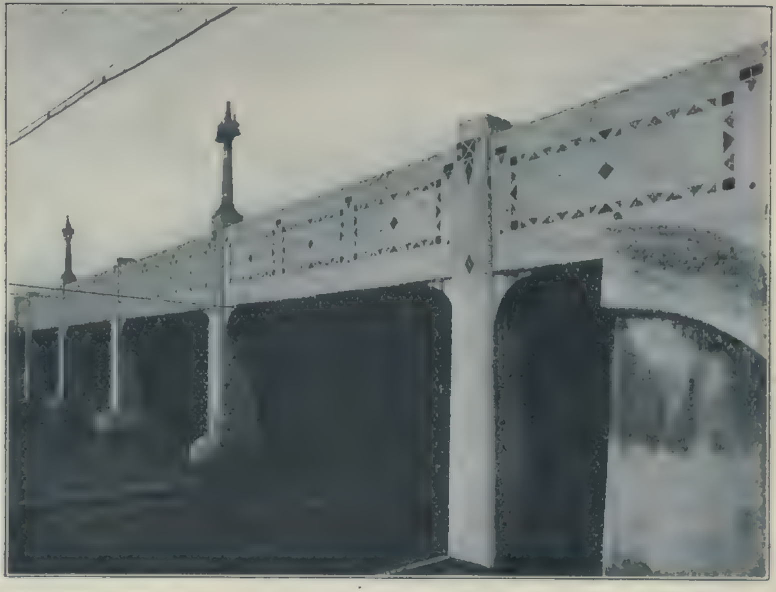


Fig. 24—Independence Boulevard Viaduct, Baltimore and Ohio Railway, Chicago

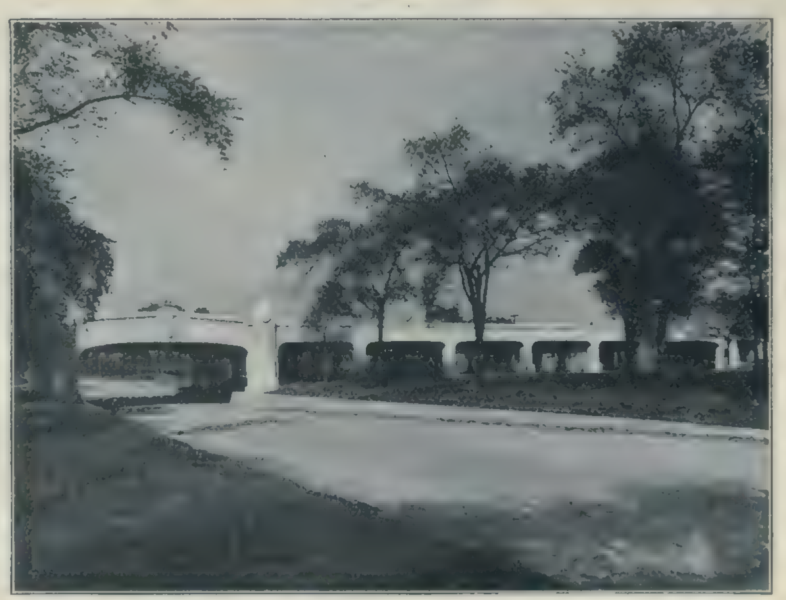


Fig. 25—Ogden Avenue Viaduct, Baltimore and Ohio Railroad, Chicago, showing tile inserts.

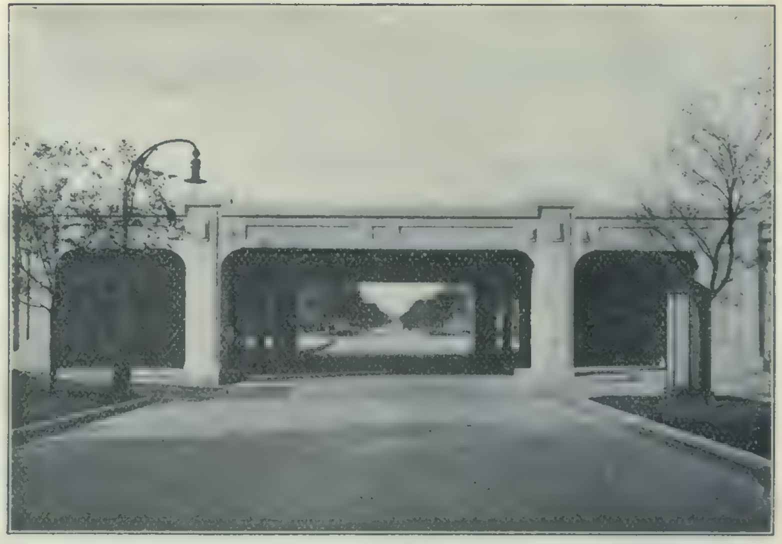


Fig. 26—Sacramento Boulevard Viaduct, Baltimore and Ohio Railroad, Chicago.

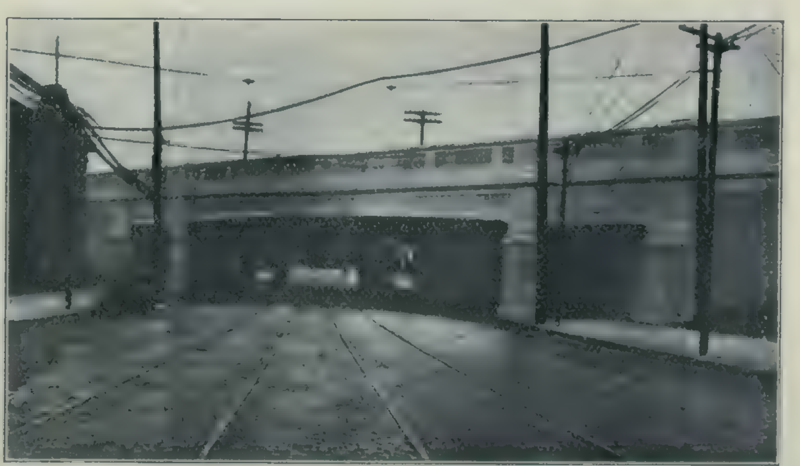


Fig. 27—Euclid Avenue Viaduct, New York, Chicago, & St. Louis Railroad, Cleveland, Ohio.

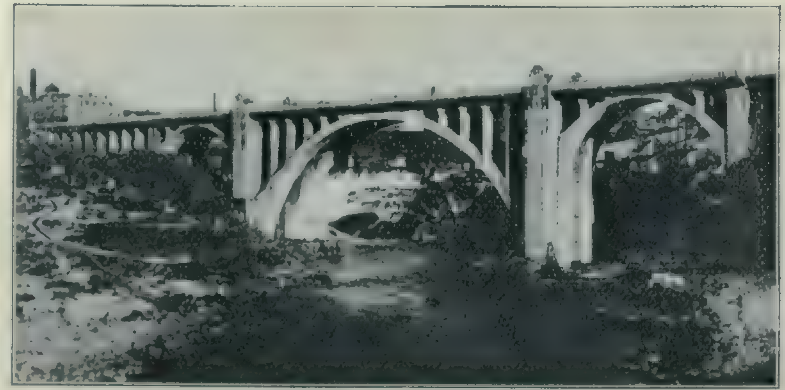


Fig. 29—Concrete arch bridge, Spokane, Wash.

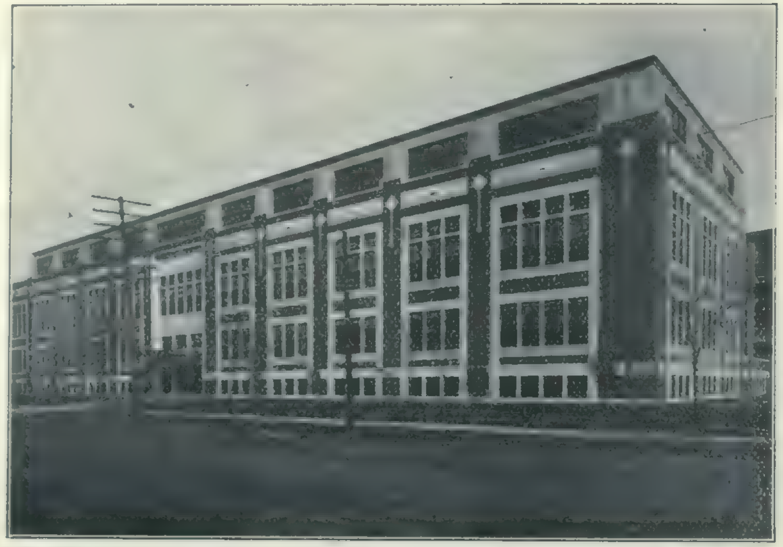


Fig 30—Office Building, Packard Automobile Company, Buffalo, N.Y.

officials made arrangements to cover the steel with concrete, in much the same manner as has been used by the B. & O. Railroad, although no particular attempt was made at architectural effect. Nevertheless, the appearance of the viaduct has been improved and its life undoubtedly materially lengthened.

Another railroad which is paying particular attention to the appearance of its viaducts is the New York, Chicago & St. Louis Railroad, under the supervision of A. J. Himes, Engineer of Grade Elimination. In the majority of instances the attempts have been thoroughly successful, although at Maysfield Road, Cleveland, the structure may be questioned as to its pleasing architecture. A great number of arches with short columns has not only made a large amount of form work necessary but has hardly justified the expense involved.

More pleasing work has been accomplished on the Euclid Avenue Bridge and at probably less unit expense (Fig. 27). In Cleveland, also, attention has been paid to the combination of landscape with structure, as indicated by the East Boulevard Bridge (Fig. 28), which is particularly well located so far as the contour and beauty of the surrounding country is concerned. The color which has been added to the arch and abutments tends only to brighten the picture and improve the general impression. The paneling for this bridge has all been finished with a bush-hammer and the red framing was obtained by mixing iron oxide with the concrete.

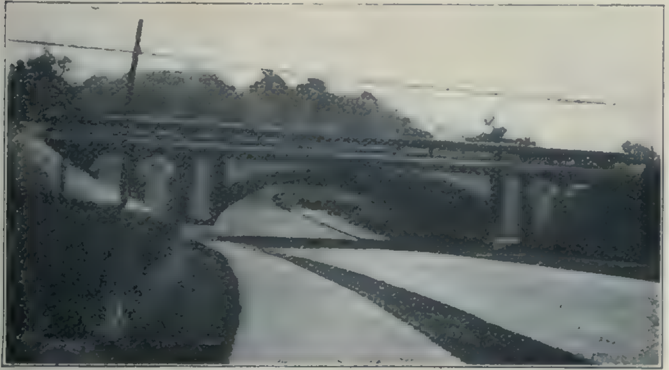


Fig. 28.—East Boulevard Bridge, New York, Chicago & St. Louis Railroad, Cleveland, Ohio.

As has been stated, massive structures are impressive, irrespective of their design or location, but the interest is generally enlivened by such a waterfall and stream as is included in the photograph of the concrete bridge at Spokane, Washington (Fig. 29). The design is undoubtedly excellent and would stand alone, uncriticized, but the touch of romance which the scenery furnishes engages the attention and makes the picture more alluring than that of the Paulinskill Viaduct of the Lackawanna Railroad at Hainesburgh, N.J. Though equally well designed, it is surrounded by uninteresting prairie on every side, which, of course, cannot by any means be charged against the bridge design.

(Concluded in next issue).

The great Ashokan aqueduct to supply the city of New York, now in course of construction, is the only modern hydraulic enterprise intended mainly for domestic and industrial use, that compares fairly with the Los Angeles aqueduct. The New York aqueduct crosses the Hudson over a thousand feet beneath the river bed, and it will furnish the metropolis with 500,000,000 American gallons daily at a cost, including its various reservoirs, of, roughly, $170,000,000. The Los Angeles aqueduct has not much more than half the capacity of the Ashokan; but it is about twice as long, passes through an incomparably rougher country, and its cost, when completed, will, it is said, be less than one-fifth that of the great New York enterprise.

Reinforced Concrete Bridge Subjected to Heavy Test Load

A heavy test load on a 40-ft. reinforced concrete highway bridge was made in 1911-12 by the Illinois Highway Commission under the direction of A. N. Johnson, the engineer for the Commission. The bridge under test was a 40-ft. reinforced concrete girder bridge, in which the two outside girders and floor were of monolithic construction. It was designed for the usual loading of 125 lb. per sq. ft. uniform load or a 24-ton traction engine load distributed over an area 10 x 12 ft. It was completed about January 1, 1908, and was tested for small loads several times previous to July, 1911, when the load here noted was placed and continued from that time until September, 1912. Deflection and deformation measurements were made at different times during the entire loading. The maximum load was equivalent to 309 tons per girder, in addition to the weight of the bridge, and the floor slab carried an applied load of 418 tons for over a year without signs of serious stress. These loads amount from nine to thirteen times the maximum load that a bridge of this kind would be expected to carry in service. The maximum stress of the longitudinal girder steel as determined from the deformation measurement was about 25,000 lb. per sq. in. The stress computed for the same load under the assumption that steel for the girders takes all the tensile stress, is 47,000 lb. per sq. in. It is rather difficult with the irregular section of the bridge to determine the exact position of the neutral axis from theoretical considerations, but it is evident from the difference between the two figures given above that the concrete must have carried in tension a considerable part of the stress.—Engineering News.

Three-hinged skew arches of reinforced concrete were built over the Berlin-Spandau canal in Berlin, Germany, two years ago. One of the bridges has a span of 157½ ft. and a rise of 16.4 ft., with a skew of 35 deg. from square crossing (intersection angle 55 deg.); the ring is 26 in. thick at crown, and 42 in. thick at the maximum in the haunches. The other bridge has a span of 148 ft., a rise of 14.7 ft., and a skew of 22 deg. (intersection angle 68 deg.). The hinges are steel castings, and the hinge lines are parallel to the abutments, i.e., parallel to the canal axis, instead of being stepped. Dowels in the hinges prevent sliding along the joint, under the slipping force due to the skew between arch thrust and hinge line. The arches were calculated as statically indeterminate structures, there being horizontal and vertical torsion moments at the crown in addition to the crown thrust. The designer, W. Nakonz, states that these moments are small and it is sufficient to calculate as for a square three-hinged arch. The bridges were built by Dyckerhoff & Widmann. These bridges showed large crown deflection on striking centers, 2¾ in. in the larger bridge and 3½ in. in the smaller, with increase of span length by about 1 in. The abutments are founded on gravel. The acute angles of the arch abutments are subjected to excess thrust in such bridges.

To Set Out Spirals by Offsets from Long Chord*

By E. S. M. Lovelace, M. Can. Soc. C. E.

THE following method of setting out spirals was worked out by the writer when Division Engineer on the Quebec & Saguenay Railway, and such good results were obtained by its use that it may be of interest to lay it before the Members of the Society.

The location of this railway (on the section now under construction between Quebec and Murray Bay) for the greater part of its length follows closely the north shore of the St. Lawrence River, an almost absolutely level line being obtainable at the expense naturally of a great deal of curvature.

There are a couple of tunnels, and some of the smaller inlets have been crossed on rock filled cribwork, but for the most part a bench to carry the line has been blasted out of the rock.

The rock cliffs on the shore side rise almost vertically to heights ranging from one hundred to a thousand feet, and to reduce the cost of the work curves running from one to ten degrees have been used liberally, the connecting tangents being necessarily of no great length.

The profile of the natural surface on the centre line therefore presented the appearance of a comb with very long teeth and the cross-sectioning and setting out of the work for the contractors was in consequence very arduous, at spots dangerous.

The difficulty was largely added to owing to the tides, there being a rise and fall of about twenty feet in this vicinity. This meant that at some places, only when the tide was out, or, for about a couple of hours each day, could any work be even attempted.

Almost invariably the beginning of spiral was found to fall in a hollow, behind some large boulder, half way up a slope, or at some other equally undesirable point, and immediately in front, perhaps, would be a pinnacle of rock. In order to continue the spiral, a hub would have to be placed on top of this pinnacle and the whole spiral then swung from a backsight of say less than thirty feet. Add a couple more intermediate hubs in order to reach the end of the spiral (these were scarcely ever over two hundred feet in length) and it will be seen that, using the method of deflection angles, a considerable amount of field calculations would be necessary and then, in order to get results even approximately correct, careful chaining and most accurate instrumental work would be required and in the writer's experience neither the one nor the other is the easiest thing in the world to obtain.

The above facts are only mentioned to show the difficulty under such conditions attending the setting out of spirals in the ordinary way by deflection angles and the method about to be described suggested itself to and was put in shape by the writer to overcome some of such difficulties.

Afterwards it was seen that the method was capable of enlargement and applicable to other cases not at first foreseen.

By using the long chord of the spiral, the instrumental work, at least, at once greatly simplified itself, for the angle CAP (θ on the accompanying diagram), being turned off in the first instance, it was only a question of prolonging a straight line to the B.C.C. (beginning of circular curve.)

Usually in a case such as described above, where the first hub is only a short distance from the B.S. it would be found possible to place also a reference mark forward or to the rear on the same line, and such mark, in place of the short back sight to the B.S. would be used for the further prolongation of the chord.

It may at once be stated that the writer does not for a moment advocate this in all cases, to the exclusion of other methods. On unbroken ground the spirals can be put in accurately enough and perhaps more expeditiously in the ordinary way, using deflection angles, than by any other method, but where the surface is very rough (requiring intermediate hubs), the experience of the writer is that the work is greatly simplified if the setting out of the spiral be done by offsets measured from the long chord.

In a trial location, through wooded country too, the advantage of this method is at once apparent, as it is only necessary to set off and cut out the long chord of the spiral, the rodman taking a shot to the right or left of the chord, should the ground require it.

Usually speaking, it will only be necessary to take such readings at the middle point of the spiral, which, as shown on the diagram, is always at a distance from the long chord of one-and-a-half times the shift, H, the shift being the distance which the main curve has been thrown back from the tangent.

The formulae (1) to (5) were submitted by the writer in a paper on Transition Curves read before the Society on December 7th, 1899, and as most of them are familiar and found in one form or another in other discussions, the writer does not propose to deal further with them here.

Number (6) however, $h = 4\ HS\,\frac{(L^2 - S^2)}{L^3}$, to be used in connection with the method under discussion, is what the writer would particularly like to draw attention to. In it, given the shift H of the main curve from the original tangent and the total length L of the spiral, then h (the offset from the long chord to a point at a distance s along the spiral from the B.S.) can be calculated.

It is a maximum when $s = \frac{L}{\sqrt{3}}$ its value, h max, being $\frac{8}{9}\ H\ \sqrt{3} = 1.54\ H$; when $s = \frac{L}{2}$, $h = \frac{3}{2}\ H = 1.5\ H$, that is the offset from long chord to centre of spiral is always three-halves of the shift.

For use in the field No. 6 can be thrown into the form given in (7) $hn = 4\ H\ N\,\frac{(A^2 - N^2)}{A^3}$ where the spiral is supposed divided into any number of chords of equal length. As spirals are not usually of a greater length than three hundred feet, it will not often be necessary to use more than eight, which would give chords of about forty feet in length, but of course when required, any number (a) of chords, odd or even, may be used, and, after substitution in (7), the results worked out in the manner indicated.

---

* Paper prepared for The Canadian Society of Civil Engineers.

In most instances, however, using spirals of two hundred feet and under, four chords or a = 4 will be found sufficient, and then the offset to the end of the first chord will always be $\frac{15}{16}$ H, to the end of the second or middle point of the spiral $\frac{3}{2}$ H, and to the end of the third $\frac{21}{16}$ H.

Using six and eight chords the results, as shown on diagram, can be tabulated (expressed decimally perhaps to simplify field computations) and marked in the field book for reference.

A word with regard to the actual field work, for in the experience of the writer, engineers (especially young ones), so often use bad judgment, and choose in practice, so far as the obtaining of accurate results is concerned, the poorer of two ways of doing a thing.

For instance, while of course it would be alright to chain along the chord if only the B.C.C. is to be established (as when going through bush), it would be very bad practice indeed to do so when setting out intermediate points on the spiral, for, quite apart from the actual difference in length of the spiral and its chord (be the same small or great), there would be involved the question of measuring the offsets exactly at right angles to this chord, a thing tedious and very difficult to do even approximately in the field.

The proper way is to chain (using the chord length chosen) along the spiral, from point to point, in the ordinary way.

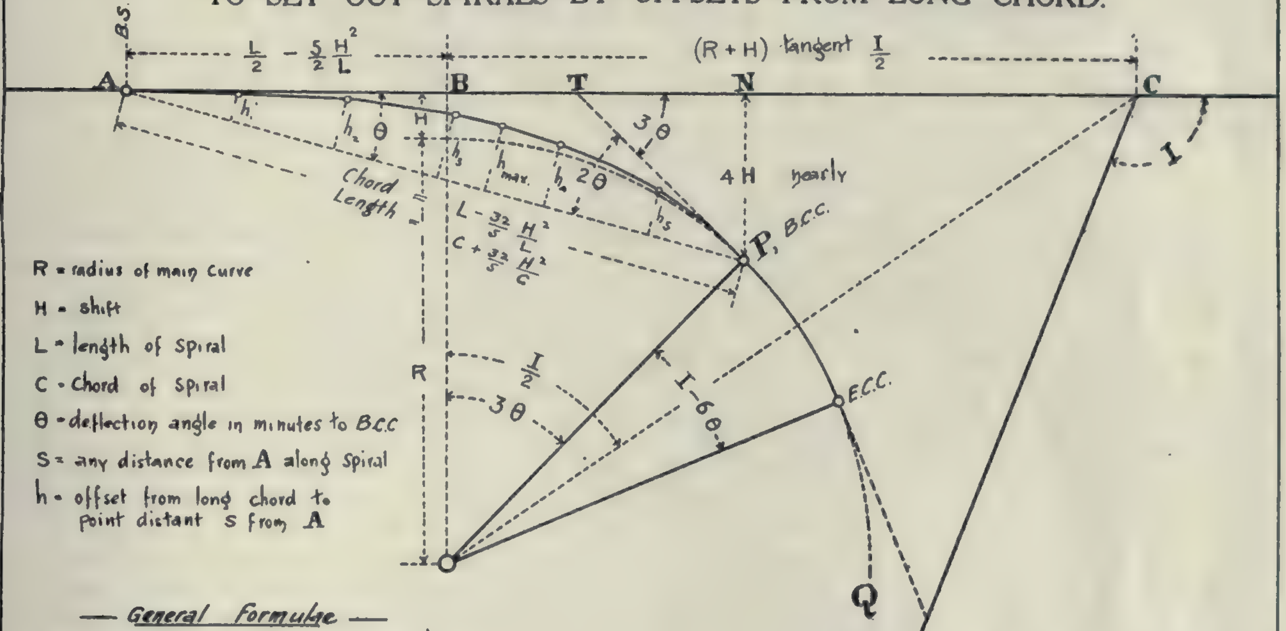
The picket man alone moves along the long chord holding (to steady it as the measurement is taken) the brass end of the tape against a picket, the front chainman with chain tightly drawn finding the correct position of the point by reading off on the tape the offset called out to him by the man at the instrument.

The transitman sights to the side of the picket or, what comes to the same thing, the exact end of the brass ring of the tape, the picket man moving this end up or down on the picket so as to keep it approximately level with the end held by the chainman.

It is only necessary for the picketman to keep somewhere near the position where a perpendicular dropped from the point being staked out would hit the long chord, for the effect on the measured offset of his being a few inches one way or the other would be inappreciable.

In giving final track centres, the position of the stake is first found, the stake driven, and then the exact

TO SET OUT SPIRALS BY OFFSETS FROM LONG CHORD.



$\frac{L}{2} - \frac{5}{2}\frac{H^2}{L}$
$(R+H)$ tangent $\frac{I}{2}$
A
B
T
N
C
I
h_1
h_2
θ
H
h_3
h_{max}
h_4
2θ
3θ
h_5
Chord Length
$L - \frac{32}{5}\frac{H^2}{L}$
$C + \frac{32}{5}\frac{H^2}{C}$
4 H nearly
P, B.C.C.
R
$\frac{I}{2}$
3θ
I-6θ
E.C.C.
Q

R = radius of main curve

H = shift

L = length of spiral

C = chord of spiral

θ = deflection angle in minutes to B.C.C

S = any distance from **A** along spiral

h = offset from long chord to point distant S from **A**

General Formulae

$$\theta = 573 \frac{L}{R} \quad (1) \quad \theta \text{ is in minutes}$$

$$H = \frac{L^2}{24R} \quad (2)$$

$$AB = \frac{L}{2} - \frac{5}{2}\frac{H^2}{L} \quad (3)$$

$$C = L - \frac{32}{5}\frac{H^2}{L} \quad (4)$$

$$L = C + \frac{32}{5}\frac{H^2}{C} \quad (5)$$

$$h = 4HS\frac{(L^2-S^2)}{L^3} \quad (6)$$

NOTE:– h is a maximum when $S = \frac{L}{\sqrt{3}}$

$\therefore h_{max} = \frac{8}{9} H\sqrt{3} = 1.54 H$

when $S = \frac{L}{2}$ $h = \frac{3}{2} H = 1.5 H$

that is, offset to centre of spiral is always $\frac{3}{2}$ of the shift:–

Suppose L divided into a chords, then length of one chord would be $\frac{L}{a}$ and length from A to end of N^{th} chord would be $\frac{NL}{a}$, substituting $\frac{NL}{a}$ for S in (6) then

$$h_N = 4HN\frac{(a^2-N^2)}{a^3} \quad (7)$$

E. S. M. LOVELACE M. Can. Soc. C. E.

For a = 4, $h_1 = \frac{15}{16}H$, $h_2 = \frac{3}{2}H$, $h_3 = \frac{21}{16}H$, $h_4 = 0$

" a = 6, $h_1 = \frac{35}{54}H$, $h_2 = \frac{32}{27}H$, $h_3 = \frac{3}{2}H$, $h_4 = \frac{40}{27}H$, $h_5 = \frac{55}{54}H$; $h_6 = 0$

" a = 8, $h_1 = \frac{63}{128}H$, $h_2 = \frac{15}{16}H$, $h_3 = \frac{165}{128}H$, $h_4 = \frac{3}{2}H$, $h_5 = \frac{195}{128}H$, $h_6 = \frac{21}{16}H$, $h_7 = \frac{105}{128}H$; $h_8 = 0$

position of the tack on the stake can be found, by taking a fresh sight and measurement.

In this way it will be seen that it is feasible to set out points on the spiral easily with no greater error than say an eighth of an inch. On the other hand, if the attempt be made to put in the spiral in the ordinary way by deflection angles, any instrument man knows that it is impossible even with the most careful manipulation to set off the angles and be sure that there is not at least an error of say half an inch. While of course it may be argued that this is close enough for the most exacting practice, still the fact remains that of the two, that of offsetting from the long chord as outlined above is the more accurate method.

It frequently happens that the end of a viaduct or trestle is on a spiral and then, the accuracy and ease with which points on the spiral could again and again be laid down in exactly the same position as the work progresses, would tend to recommend the use in such a case of this method of offsetting from the long chord.

For electric tramways, etc., where the spirals are short, the above method and conclusions apply, the only difference being that it might be more convenient at times to use, in place of a transit, a piece of twine actually stretched to mark out the long chord, the offsets to points on the spiral being measured directly from this line.

When locating on side hill, or when, for one reason or another a line has to be very closely fitted to the ground, a problem frequently occuring is that case where a fixed tangent has to be connected with a curve already established. Should a simple curve answer the purpose well and good; but it will often happen that the requirements necessitate the use of a compound curve, and in that event, a simpler solution, the writer has found, is to at once employ, in place of the compound, one long, continuous spiral. While the elements of such a spiral could doubtless be worked out using the ordinary methods, yet nevertheless, the solution is given here as the question of setting out the spiral simplifies itself to some extent by using offsets from the long chord.

Referring to the diagram and formulae; suppose AC the fixed tangent and PQ the established curve.

Find T the point of intersection of the tangent to the curve at P with AC.

Measure PT and the angle PTN = 3θ.

In the triangle PTA, the side PT and angles PAT = θ and TPA = 2θ are known and therefore the sides PA and TA can be calculated.

Also, NP = PT Sin. PTN = 4H (nearly) is known.

Use ¼NP as a value for H in formula (5), C being the side PA, and get the length L of the spiral.

Knowing θ and L, the radius of curvature r of the spiral at P is given by (1) $r = \frac{573\ L}{\theta}$, θ being expressed in minutes.

An accurate value of H can then be found from

$$(2)\ H = \frac{L^2}{24\ r}$$

TA is measured off along the tangent and A becomes the B.S. The spiral is then staked out as described above by placing the instrument at A or P and measuring the offsets from the long chord AP.

It should be noted that r, the radius of curvature of the spiral at P (supposing P has been chosen at random on the ground), is not necessarily equal in length to R the radius of the main curve; neither is it essential that it should be so, for the point P can then be regarded simply as a point of compound curvature.

If thought necessary, however, the position of the point on the established curve where r would equal R could be found by using the work done as described above upon which to base a new calculation, for

NP + R cos PTN — R would give the value of H for the required spiral

then $L = \sqrt{24\ RH}$ by (2)

and $\theta = \frac{573\ L}{R}$ by (1)

therefore the point required on the established curve would be found forward or backward from P according as 3θ is greater or less than PTN, the actual distance on this main circular curve corresponding to a central angle of (3θ — PTN).

Precisely the same problem as the above occurs at times when giving final track centres on construction. In such cases it is usually the result of incorrect measurements or inaccuracies in the instrumental work which have crept in during the progress of the work.

Of course it might be argued that such errors should not have been made, but the fact remains that to a greater or lesser extent they are always present and must therefore be considered.

What happens frequently is this: the points A and P on the diagram, that is the beginning and end of the spiral have perhaps been referenced at the time the location was made and therefore at a time when the natural surface of the ground was in quite a different condition from its present.

When track centres are being given these points are again run in but are found now not to have the same relative position to one another that they had originally.

The point A has perhaps moved a couple of inches to one side of its original position, and the point P an inch or two to the other, so that when the transit is set up at A and sighted to P the actual angle between the tangent and P does not agree with the original angle θ.

The discrepancy may be small and negligible, or it may amount to several minutes, in which case some adjustment will be found necessary.

Very often the easiest way to make this adjustment (more especially when the main curve is already lined up and its position therefore fixed) is to proceed in the manner indicated above, that is set up at P, run in and measure the line PT, measure the angle PTN, which is three times the new spiral angle, calculate the distance TA, measure it out along the tangent and thus get the new position of the B.S. The spiral can then be run in either by deflection angles or by offsets from the long chord. TP will of course be a tangent to both spiral and main curve at P, but as previously mentioned the radii of spiral and main curve at P will not of necessity be exactly equal.

Bellefontaine, Ohio, claims to have the oldest concrete road ever built. The road was built twenty years ago and is still in a good state of preservation, being still used for heavy traffic every day. The pavement consists of a 4-inch concrete base and a 2-inch wearing surface; the base being 1:2:4 machine mixed gravel concrete and the top a 1:1 mixture of cement and bank sand. The concrete base was laid quite dry, was thoroughly tamped and the top was laid closely, behind the base. This pavement was laid really in blocks five feet square. To afford a foothold for horses the surface, after being smoothed with a trowel was roughened.

Organizing and Executing the Construction of a Reinforced Concrete Industrial Building*—Part 1

By Leonard C. Wason

SEEING that sometimes the owner takes an active interest in the execution of the work, although he deals through his engineer or architect, it is of considerable importance to know his temperament and point of view. Greater harmony will thus be obtained. The engineer will do well to bring both parties together early and often. There is the owner who has not been seen at the time of that payment, and the one who is in evidence every day—the one who has a technical training and knows, and the one who does not know about construction, but thinks he does, and personally mixes into the work commonly considered as the engineer's. If the engineer is weak-kneed with the last-named type of owner expense and misunderstanding are almost certain to result, primarily because no man can serve two masters, and, secondarily, beceause an ignorant master, the owner, is never satisfied. If there is a very strong, fair-minded engineer who commands the respect of his client there is little trouble with any type of owner.

Then it is necessary to study the engineer or architect and consider his method of handling and supervising work. The methods of some engineers are radically different from those of others; this has a marked bearing upon the cost of the work and sometimes on its desirability to the contractor. The contractor must determine what sort of treatment he will receive. Nothing adds to the price of a bid like uncertainty, whether it be in the temperament of engineer and owner or in unknown construction problems.

In one case where a number of local firms were invited to bid on a certain large building for an architect who was well known always to rule in favor of his client, irrespective of the merits of the case, the successful bidder, after figuring full measure on all quantities, added this item—"Humor architect"; the item was 10 per cent. of the contract. It is safe to presume that all other competitors placed this contingency at a higher figure. Such a man could not get a reasonable bid from any one who knew him, and he certainly could not expect to let work advantageously to guileless strangers.

One of the great problems which the contractor has to face is that of the inspector who represents the engineer on the work. A thoroughly competent inspector is a great help to the contractor and very beneficial in the results obtained. An incompetent one is exactly the reverse. The writer recognizes the difficulties the engineer labors under in selecting his inspector. The duties are not hard, and to the man with ability, ambition and push, the close confinement to long hours of attendance on the work, with little to do except keep his eyes open, is too irksome to be long endured, even at a good salary, and this desirable type soon moves to what he considers better employment. The most important thing to consider in the appointment of an inexperienced man is his temperament. He must have an even temper not easily ruffled, be considerate yet firm, always diplomatic, and be capable of performing his duties acceptably to his employer.

The superintendent for the contractor is necessarily better informed and trained in construction, an executive who is constantly directing others and quick to resist for the good of the service insubordination or usurpation of the duties for which he is held to strict account by his employer. In other words, he is trained to be an autocrat. This temperament does not take kindly to being bossed by a younger man admittedly with less experience. Therefore, the inspector must have the above-named qualities and also must not consider it a personal affront when his orders are overruled. He will make some mistakes which the engineer will correct, and many more, alas, which his chief will never hear about, although they make unnecessary expense and may affect his chief's professional reputation. He is put in a trying position, left too much alone and required to perform certain duties, but he must not go beyond bounds.

The very first step which a contractor must take in starting the execution of a job is selecting a general superintendent to handle the work. The type that is hired for a single job and discharged at its completion is not worth having. The really desirable superintendent is a development from experience, the one survival from many tried, and when once obtained a firm cannot afford to lose him. Some owners and engineers appreciate the value of personality so much that they have given the writer's company contracts under condition that a certain superintendent be put in charge.

Desiderata in a Building Inspector

If a building superintendent is to be successful he must combine at least seven qualities. He must have brains, special and technical knowledge of both direct contract and sub-contract work, tact, energy, honesty, judgment and good health. He must have a personality which drives to activity several hundred originally unorganized men who are without special interest in the company they work for or in the result accomplished, and with such tact and judgment as to weld them into a harmonious working force, cheerful and self-respecting, with high morals and ultimately with enthusiasm for the work in hand. He carries a care so great that he builds in full size, with permanent materials, the intricacies of design which trouble the engineer's drafting room to show clearly on paper; with an honor so fine that the company is ready to leave its reputation in his hands, to trust him with funds; and with special experience so trained that dangerous operations are carried on as a matter of routine, without worry to himself or the company, yet with a constant oversight of a thousand chances for accident or perhaps death which may occur to the men in his charge; with a forethought so great that he sees ahead and provides for the problems which are to come up perhaps months later; with a temper so good that he never loses self-control under the most provoking circumstances, and is able to take with the best of grace changes in his plans from the office, and to work in the close co-operation with the company which is so necessary to make it an effective contracting organization.

Such men have a temperament that responds quickly to criticism or praise. Praise comes sparingly, even when deserved, while criticism is freely meted out. The attitude of the engineer in this respect is reflected in the execution of the work. One engineer may call attention to a mistake with a letter that is harsh and ends with a sting, which leaves the feeling of injustice and soreness in the recipient. Another, in calling attention to a similar mistake, ends his letter with some expression like the following: "We appreciate your wish to make this work as satisfactory as possible, and recognize that this occurred through failure to understand my exact requirements." In response to such a letter as the first, the tendency is to do just as little as will satisfy the engineer and take your own time about it. But, as the writer knows from personal experience, in response to the second letter, you jump to correct the trouble cheerfully, quickly and without comment, and also sometimes do more than was asked for.

---

* From a paper published by the Association of Engineering Societies and abstracted by the Engineering Record.

The Contract

The type of contract is manifestly of considerable importance. It is the firm opinion of the writer that the usual type of lump-sum contract obtained in competitive bidding does not give an owner the best results. With competitive bidding open to all, the lowest bidder is liable to be one who does not use the best of methods, is looking for all sorts of short cuts, and is frequently one with a limited amount of experience and capital. It has been often noted that those new in the reinforced concrete field underestimate the difficulty and cost and do work badly at first, no matter how experienced in other lines. The lowest bidder is squeezed to a figure where it is known he cannot make much, if anything, and there is every incentive to save and slight. This condition of necessity encourages mutual suspicion and antagonism before the start; therefore, the best results are impossible. No amount of careful inspection can make an inexperienced or incompetent contractor turn out thoroughly first-class work.

On the other hand, under the cost-plus-fixed-sum-for-profit type of contract the interests of the owner, builder and engineer are one. Work obtained in this way is certain to be much better for the same cost; even if the cost is slightly greater, the owner has the assurance that he is getting much more for his money. The majority of manufacturers whom the writer knows look upon a mill building as a tool to be used in a manufacturing process, rather than as real estate, and want to get a thoroughly first-class tool rather than the absolute last dollar knocked off the first cost of real estate, and, therefore, believe the extra cost justified. The engineer can examine the estimate of cost as prepared by the contractor, discuss savings or changes, and can see places where he is willing to cut the design when he knows that there is not going to be still further cut in the execution of the work. When he knows that the work is going to be executed exactly as designed he can design with greater precision and economy than when he has to provide extra strength or size of members to allow for a possible lack of quality of materials and workmanship by some unknown person who may have the execution of the work in hand. The work can be carried on also much faster under this method of close co-operation than under the other, where there are likely to be misunderstandings which must be adjusted before the work progresses further. What the contractor has to sell is service, and what the owner wants is results, and where this mutuality exists both parties can accomplish the end which they are striving for.

If the owner wants to start as soon as he engages an engineer and before plans are started, he can save about six weeks' time with no serious difference of cost on the cost-plus-fixed-sum basis.

The engineer and owner do not sufficiently appreciate that the builder or contractor is largely a broker buying materials. With an office building, for instance, the general contractor may not handle more than ten per cent. of the contract price as direct labor. The rest is materials bought and sub-contracts let. With reinforced concrete the percentage of labor is larger than in any other building operation. It averages about 35 per cent. of the cost. The contractor, therefore, realizes the necessity of a first-class purchasing department.

Preliminary Work

When a contract is awarded and a set of plans received from the engineer a considerable amount of work is done in the main office, beginning long before any work is started in the field and continued during the early stages of construction in two departments—the designing and the purchasing.

The function of the designing department is to take the complete set of plans and make a careful study of these in regard to designing forms, tabulating steel and illustrating and tabulating other materials, such as doors, windows, architectural iron, etc., where this is not done in the engineer's office. The location of construction and contraction joints is studied, and on rare occasions the structural design is reviewed. In the writer's practice it is common to close a contract and start building before any working drawings are made. Then the work and responsibility thrown on the designing department are very great.

Chief among the minor features not shown on the plans are the means to be provided to prevent cracks, which mar the appearance and are often a source of annoyance, though seldom a cause of structural weakness. There are sometimes cracks caused by unequal settlement of foundation. Sometimes a part of a building is on piles and part on earth. Where they join it is hard to foresee and provide such an amount of bearing that the whole will settle evenly. It is usually best to provide a broader bearing on the less rigid material than theory dictates; then unsightly cracks may be avoided by very rigid tying of the building together with reinforcement, against pulling apart longitudinally or shearing. This requires both horizontal and diagonal reinforcement with a minimum quantity, equal to at least one-half of one per cent. of area of concrete.

Another way to overcome the same difficulty is by building a joint vertically clear through the structure at this point and designing the members of the structures on either side so that if settlement does occur they will not crack. This was done with satisfactory results in a recent building where one end rested upon sand, and center on ledge and the other end on clay.

On the ground of cheapness of construction, it is almost always better to put curtain walls in after the frame is up; the work then goes ahead much faster. Weather-tight joints can readily be made, and the joints between the frame, that is, the columns and floor, can be concealed so that no unsightly crack is visible.

Another point of design which may sometimes be advantageously discussed by the engineer is that of roof construction; whether the structural part shall be flat and covered with cinders, to give a proper pitch for drainage, or whether the ceiling shall be pitched and the fill avoided. In construction the most serious objection to the first method is that so much time elapses between the casting of the roof and the waterproof cover of tar and felt over the cinder fill that a considerable quantity of rain collects on top of the roof slab. These slabs, while not absolutely watertight, are tight enough to hold a considerable quantity of water. On some jobs holes had to be drilled from ceiling to drain roof slabs. In one building water dripped from the ceiling after it had been waterproofed for a period of five months, due to the collection of water on the slab in the cinder fill. In another case there was some dripping even after two years. This is a matter entirely beyond the control of the contractor.

It is somewhat common to put wall beams above the floor on account of letting in light at the ceiling line. Then the question arises whether the beams shall be cast with the floor or be cast separately. It is generally cheaper and of equally good construction to cast the wall beam as a separate operation, allowing the ends to rest in rebates in the columns and suspending the slab below by means of stirrups. Provision can be made for continuity by casting some holes in the columns above the floor at the proper points, through which the reinforcement for negative bending moments will pass, allowing the ends to extend well out in the adjacent panels. When properly grouted into place and panel cast this will be as strong as if cast as a monolith with the floor.

In one building of large size, in a single floor there were in the original design received 455 different sizes and styles of beams. The designing department of the writer's company found it possible, without impairing the result to be accomplished, to reduce these to less than a tenth of the original number, and by co-operation with the engineers finally succeeded in reducing the number to 52. If the engineers realize that in the building of wooden forms for maximum economy these are made from plans drawn to scale at a bench on the ground and assembled in place without the use of any tool but a hammer, it will be seen that almost as great precision must be used in construction as with structural steel.

The question of change of size of columns in every storey, or once in two or three storeys, is one of cost. The expense of changing the forms is usually greater than the cost of concrete saved on small columns where the reduction is less than three inches, and on large columns where the reduction is less than two inches. Therefore, it is not often economical to change the size every storey. Often when the column is reduced it is desirable to use ahead the size of lowest storey columns in order to avoid the expense of splicing out beam and girder sides and bottoms. Sometimes when the upper floor has a lighter load than the lower it would be possible to reduce the size of beams. Economy dictates that the depth may be reduced but not their width, because this would require splicing out all the floor panels and joists, which is more expensive than the saving in concrete.

General Methods of Repairs and Renewals in Road Work*

By A. W. Dean†

REPAIRS and renewals of highway surfaces are matters of as great importance as the original construction—possibly greater, in that construction may be deferred for a period without serious loss, whereas repairs must often be made immediately when the necessity occurs. If a highway is properly built it will require very little attention for some time, but if its improperly built, repairs are called for immediately and renewals soon follow. A properly built highway is one properly designed to meet existing and anticipated traffic and other conditions, built with good quality of material and workmanship. Obviously, not every highway is or can be built properly, hence the problems of repairs and renewals are constantly before us.

Let us first give attention to the dirt road, of which there is a greater mileage than of any other single type. Apart from the bridges and culverts, the repairs on such roads may be made very largely by the use of a road drag, with the occasional use of a road machine. The drag is a comparatively new type of implement, but has been so widely advertised that it is perhaps not necessary to describe it at this time. Whether made of split logs, plank or steel, it is serviceable and should be used when the dirt is full of moisture, but not sufficiently so to be muddy. Frequent dragging will keep the average dirt road in good condition, and the road machine should be used only when it is desired to increase the width of section. Repairs and renewals are synonymous terms in this method of maintenance of dirt roads, in that every time a drag or road machine is used for repairs, the surface is renewed to some extent.

Sand-clay roads being essentially improved dirt roads, are repaired in much the same manner, but with perhaps more care. In addition to dragging, it becomes necessary to add more clay, or sand, or both, to strengthen weak spots that may develop. Renewals are made by adding to the entire surface, without previous preparation thereof, a layer of sand and clay properly proportioned, and mixing same by harrowing.

Gravel Surface

Next in order of permanence is the gravel surface. So widely varying types of surfaces are described as gravel, that it might be well to limit the definition of gravel as material in which the mixture of round stones and particles is quite uniformly variable in size from minute particles to stones two or three inches in diameter. Repairs of gravel roads are frequently made, to some extent, by the use of the drag, but should not be made with a road machine except, as in the case of the dirt road, when it is desired to widen the travelled surface and sometimes to lightly smooth the surface. Whenever it is used for widening the travelled section, the material that is scraped from the sides should in no case be left on the road surface, but should be either carted away or thrown outside of the section worked. Renewals are made by simply spreading additional gravel over the surface without previous preparation thereof, and watering and rolling, if possible, but if not possible, permitting the traffic to compact the material.

---

* Paper presented at the tenth annual convention of the American Road Builders' Association, Philadelphia, Pa., Dec. 9-12, 1913.

† Chief Engineer, Massachusetts State Highway Commission.

Maintenance of a broken stone macadam road whenever constructed by the usual method (ordinarily termed as water bound macadam) is a more or less difficult problem, depending upon the traffic that it has to withstand. If the traffic is sufficient to wear out the surface rapidly and cause so-called "pot-holes" to appear, the practice of repairing or renewing it by adding stone without a foreign binder, is questionable. If, however, such traffic conditions do not exist, repairs are made by loosening the upper surface of the section to be repaired, adding broken stone of small dimensions, with sufficient stone dust to fill the voids, and compacting by rolling. Renewals are made by adding more stone to the entire surface in the same manner that the upper course of the road surface was originally constructed. If the thickness of the newly added surface is less than 3 ins. better results are obtained by loosening the old surface, reshaping and rolling it before adding the new surface.

The changes and development in the use of motor vehicles, trucks and tractors, make it appear advisable, however, in the repairs and renewals of macadam roads, to use a bituminous binder. This use of bituminous binder has become quite universal in many sections of this country during the last few years, and the problem of repair and renewal of bituminous bound or surfaced highways, is gradually, through experience, becoming simplified. Repairs on a bituminous blanket or thin surface coat may be made by covering the section to be repaired with a thin coat of asphaltic oil or tar as the case may be, and immediately covering with pea stone, fine gravel or coarse sand. This is assuming that the repairs consist of renewing comparatively small sections of the coating that for any reason may have disappeared. No general fixed method can be described for making rapairs due to imperfect workmanship, the use of too much bituminous material, or the irregular distribution of material, each case having to be treated in such manner as experience may have shown to be best. Renewals of bituminous carpets may ordinarily be made by a repetition of the usual process of constructing such carpets, except that it is advisable always to use less bituminous material per square yard for renewal than was used in the original carpet.

So-called sand and oil mixed road surfaces are either repaired or renewed by the addition of mixed material of the same quality and density as that used in the original surface.

Bituminous grouted or mixed macadam surfaces should not require early or frequent repairs or renewals if designed and constructed properly in the first instance. Should the necessity for repairs arise, however, they are ordinarily made by the removal of all disintegrated or imperfect portions of the surface, and by substituting therefore a mixture of bitumen and small broken stone, the mixture being made either by mixing previous to application or by spreading stone and filling the voids by pouring. In renewing bituminous macadam surfaces it is not ordinarily necessary to break up or remove any of the existing surface, but the new surface may be added by spreading directly over the old surface. If, however, the old surface in addition to having become worn thin is worn very irregularly, it is advisable to loosen up, scarify, reshape and roll the old surface before adding the new surface material.

The repair of cement concrete surfaces is a comparatively new problem, as such surfaces have not been in use for many years, and such repairs as have been required have been due to imperfect workmanship or material. If the defects to be repaired consist of badly disintegrated sections, they cannot be permanently repaired except by the removal of all material in the sections to the full depth of the surface, and replacing same with new and proper concrete. If the defects to be repaired are minor, however, and consist merely of small depressions, they may be repaired by filling the depressions with a bituminous mixture. When a cement concrete surface becomes worn sufficiently to appear to require renewal, it is impossible to renew same by adding a new thin coat of cement concrete mixture, therefore, it may be said that a cement concrete surface cannot be renewed with the same type of surface, but must be entirely removed and a new section constructed. This would be expensive, however, and it appears that the proper method for bringing up an old concrete surface is to cover it with a bituminous bound surface of some type, thereby creating a bituminous surface in place of a cement concrete surface.

Block pavements of all kinds can be repaired or renewed only by the entire removal and replacement of the sections to be repaired or renewed.

To go into details of all the methods for repairs and renewals of all types of surfaces would obviously require a document of much length, and the speaker has not attempted to cover details, but has merely presented enough material to bring out points that might lead to a discussion of the features of most interest.

The Provincial Courthouse Addition, Vancouver

THE extensive new addition to the provincial court house at Vancouver, upon which work is now practically completed, embodies constructional features of a type which place it in a leading position among the many fine buildings of recent erection in various parts of the city. The structure was designed by Mr. Thos. Hooper and is in complete harmony with the architectural scheme of the main building at the rear of which it has been erected. The frontage is 86 feet on Robson street and the depth is 110 feet on Hornby street. Granite is used entirely for the exterior facing of the ground floor, the walls of the upper storeys being of Haddington Island stone. The design of the main entrance has been carried out in a manner strictly in keeping with the dignified appearance of the whole scheme. A columnar entrance portico faces on Robson street, the

New extension to provincial courthouse at Vancouver.

approach consisting of a flight of granite steps, with granite pedestals at each side, upon which will be placed bronze electroliers ten feet in height.

The main entrance hallway is panelled from floor to ceiling in Alaska and Vermont marble, and the corridors throughout are wainscotted in the same material to a height of 5 ft. 6 in., marble being also employed in the staircases, which have wrought iron balustrades. All floors are constructed of 6-inch concrete reinforced with Clinton fireproof fabric, and covered with interlocking rubber tile in the corridors, the floors of the departments being covered with 1 x 8-inch shiplap and finished in 1 x 3-inch fir. The materials used for roofing purposes consist of copper, asphalt and gravel.

A connecting corridor, 40 feet long and extending to the third storey of each building, affords communication between the new addition and the main structure. The lower part of this corridor is constructed of solid granite and is lined in the interior with Haddington Island stone, and floored in tile. A duct connects the basements of the present building and the new addition, while the ground floor forms a colonnade with arched stone work between the columns. The upper portion is entirely enclosed.

The ground floor is occupied by the Stipendiary Court, barristers' rooms, offices of the provincial inspector of dykes, provincial fire warden, provincial road inspector, and others. The first floor contains the offices of the government agent, provincial timber inspector, assessor and official scaler, with vaults adjoining. Located on the second floor are the large and small Supreme Courts, and a number of offices and apartments in connection therewith. The offices of the game warden cover the greater part of the third floor, in which are also situated several apartments which have not yet been assigned to any special purpose.

The heating of the addition is provided by connection with the plant located in the basement of the main building, the Webster Modulating System with Powers regulator attachments being employed throughout. The Webster ventilating system has been installed in the addition.

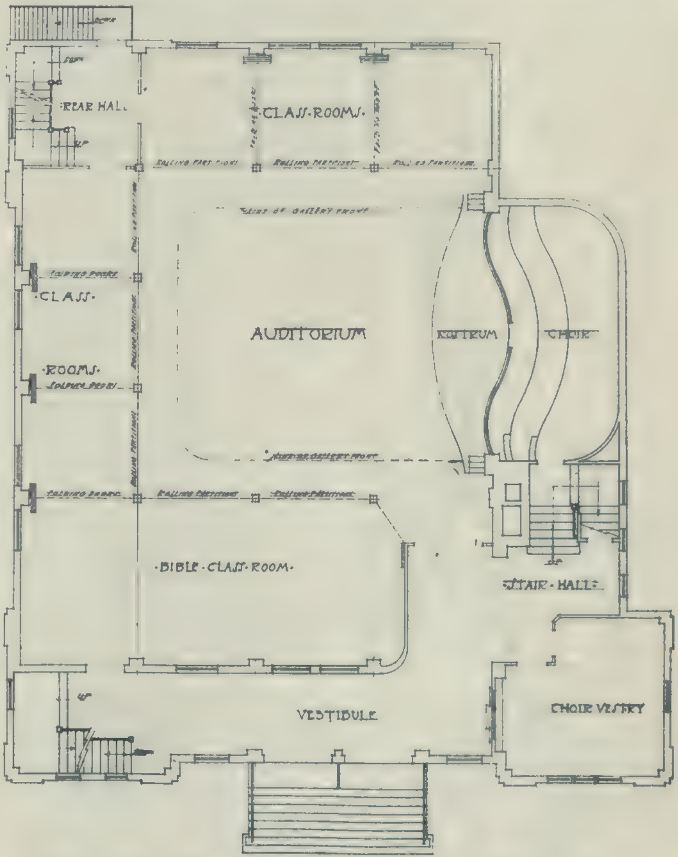
The main entrance doorway and all double acting doors in the building are fitted with "Highmac" spring hinges, invented in Vancouver and manufactured by Harcourts, Limited, of Birmingham, England.

Messrs. McDonald & Wilson, who were the contractors for the main structure, are also erecting the addition, the cost of which will amount to about $400,000. It is understood that plans have been completed by a Vancouver firm of architects for a second addition, of corresponding design and similar cost, upon which active construction will probably be inaugurated early in March, the steadily growing business of the provincial authorities necessitating still more extensive quarters.

A question which must often have occurred to engineers who have followed with any minuteness the construction of the Panama Canal, and who have noted the enormous outlay which has been necessary upon machinery and equipment plant is, "What will become of all this costly equipment when the Canal is once completed?" A partial solution of the problem has now been afforded by the announcement that a large portion of the Canal machinery and equipment when finished with will be sent to Alaska for use in railway and dock construction and coal mining. The Isthmian Canal Commission has been asked to supply the United States Senate with information showing as nearly as possible the amount, character and value of construction machinery and material which will be available on the completion of the Panama Canal.

Canada's First Reinforced Concrete Church

WHAT is said to be the first reinforced concrete church building erected in the Dominion has recently been completed for the Kitsilano Methodist congregation on the corner of Second avenue and Larch street, Vancouver. Comprising the first unit of a large church to be erected later at this location, the present building, which will eventually be utilized for Sunday School and social purposes, has cost $28,000 and will accommodate 720 people. The structure rests on 18-inch square reinforced concrete columns, and has 7-inch walls. It combines an auditorium with a Sunday school building and church home series of apartments and parlors. Ample stairways, entrances and exits are provided throughout. The interior finish consists entirely of cotton-wood mahogany, a product of British Columbia manufacture. The heating and ventilation of the building is accomplished by means of a No. 90 Pease Economy Heater, designed and installed by the Pease Pacific Foundry Company, of Vancouver. This equipment forces air over the heater with a large blower, having a capacity of 10,000 cubic feet per minute and changes the air in the building six times an hour. The system is designed in a manner which permits the use of the blower for ventilation purposes during the summer months. The artificial illumination of the interior is provided by an indirect system of lighting. Mr. Thos. Hooper was the architect for the building and Mr. S. Olsen had charge of the general contract.



Ground floor plan, Kitsilano Methodist Sunday School.

Much Activity in Prospect at the Coast

Conditions Generally Satisfactory—Large Hospital Expenditure at Vancouver—Extensive Harbor Works Planned at Kitsilano—Victoria Busy

Correspondence of the Contract Record.

Vancouver, B.C., Jan. 6, 1914.

JUDGING from the number and character of the various building projects upon which work has been scheduled to commence at Vancouver, Victoria and other points in the province within the next few months, the prospects for the early part of the new year in the British Columbia field may be described as satisfactory, despite the continued tightness of money at the Coast. The constructional programme of both the Dominion and Provincial governments in British Columbia for the ensuing year are of unusually wide scope and should contribute in a marked degree towards the prosperity of the province as a whole.

As far as Vancouver is concerned, the volume of building projected compares very favorably with that of the beginning of the past two seasons. Some of the large contracts on which it is announced that an early start will be made are the new additions to the general hospital, costing approximately $200,000; the proposed sub-postoffice in Mount Pleasant representing an outlay of $100,000; another new addition to the provincial court house, costing about $400,000; the proposed immigration shed, estimated expenditure approximately $300,000; a new drill hall in Grandview costing about $250,000; the British Columbia University buildings, representing an expenditure of several millions of dollars; proposed six-storey reinforced concrete warehouse for Cope & Son, electrical contractors; a $40,000 annex to the wholesale warehouse of Kelly Douglas & Company; a six-storey cold storage warehouse for the Vancouver Prince Rupert Cold Storage Company. These and other smaller contracts will help to swell the Vancouver building totals during the next few months.

Then there is also to be considered the bank and office building, which is being contemplated for early construction by the Canadian Bank of Commerce, and two other large buildings of the same nature which it is reported will be created in the near future by the Merchants Bank and the Royal Bank, details of which are not at present available, but the sites for which have already been secured in central parts of the city.

In Victoria there is a large amount of building construction contemplated by the Dominion and Provincial authorities, in addition to several extensive contracts which are being planned for an early start by various private interests.

While it is the intention of the Vancouver civic authorities to submit very few improvement by-laws for the coming year, there is expected to be almost five million dollars available for general municipal work.

The value of building permits issued at Vancouver during the year 1913 indicates a considerable falling-off compared with the figures for the previous twelve months, permits to the number of 2,017 being taken out, representing an outlay of $10,423,547. In 1912 there were 3,213 permits issued, valued at $19,428,432.

Following the recent announcement that the Canadian Bank of Commerce had purchased the south-west corner of Main and Pender streets, Vancouver, comes the statement from the local officials that instructions have been issued for the preparation of plans for a bank and office building to be erected on this site. While it is freely reported that constructional operations will be started early in the new year, no confirmation of this rumor can be obtained from the Vancouver officials of the bank who are averse to supplying any further information on the subject for the present.

The Vancouver architectural firm of Doctor, Stewart & Davie, is engaged in the preparation of plans for a five-storey warehouse and storage building to be located in the C. P. R. reserve. The building will occupy a lot with an area of 45 x 100 feet, and will be of brick and mill construction, with concrete for the foundations and ground floor. The general equipment will include two steel rolling doors and a freight elevator. It is understood that contract tenders will not be called for until about the end of January.

Plans were recently completed by Mr. W. F. Gardiner for a proposed store and rooms building to be erected for Mr. C. M. Bowman at the corner of Main and Broadway streets, Vancouver. The structure will measure 100 x 100 feet, and will be two-storeys in height with part basement. The exterior construction will consist of face brick with trimmings of Monarch art stone. On the ground floor there will be five stores and a 40-foot frontage space devoted to the use of a proposed moving picture theatre. The first storey will contain 45 rooms and offices equipped with the usual modern facilities. It is expected that construction work on this building will be inaugurated immediately.

Large Hospital Expenditure

During the third week in December the local firm of Booker, Campbell and Whipple was awarded the general contract for the proposed reinforced concrete and brick Nurses' Home and central wing additions to the Vancouver General Hospital, the figures of the successful tenderers being $199,921. So far as possible it has been decided to use home-manufactured products and local labor in connection with this contract. The hospital board announces that work will be undertaken and construction carried on without delay as the necessary funds are now available. The provincial authorities have been asked for an additional grant of $250,000 to apply on the hospital. It is believed that the total work planned in connection with the new addition will represent an outlay of approximately $800,000.

Mr. Thomas Hooper, a Vancouver architect, has been commissioned to prepare plans and detail drawings for the proposed factory buildings, warehouse and office accommodations, and a wharf for the Royal Crown Soap Company, of Vancouver, to be constructed on the foreshore of Burrard Inlet, near East Vancouver Heights. The plans for the wharf, it is expected, will be ready for contractors to figure on about the middle of January, and it is believed that tenders may be invited for the factory buildings about February 1. While no definite amount has been stipulated, it is understood that the total work will aggregate in cost about $250,000. The company owns a site embracing seven acres.

Plans are being prepared by Mr. R. A. Nicolais for a modern apartment building which is to be erected at the corner of Fifth avenue and Pine street, Vancouver, for Mr. E. French of this city. The structure will be planned with two wings each two storeys high and having a street frontage of 50 feet with a large court in the centre. The construction will consist of frame and brick veneer. Both floors of each building will contain nine apartments, which are to be equipped with disappearing beds and other up-to-date conveniences. The cost of the work has been estimated at about $20,000. No tenders will be taken at present.

The Vancouver-Prince Rupert Meat Company has decided to establish a modern cold storage warehouse on Water street, Vancouver, construction of which will be undertaken immediately following the completion of the plans. At present writing the officials have not decided as to whether the proposed building will be of reinforced concrete or brick and mill construction. The plans are to be prepared by the company's draughting department.

Mr. Emil Guenther, a Vancouver architect, has been commissioned by the building committee of the Fraternal Order of Eagles to prepare plans and specifications for the erection of their proposed lodge hall and building on Homer street, Vancouver, between Dunsmuir and Pender streets. The new structure will consist of three storeys and part basement, the ground measurements being 50 x 120 feet. The ground floor will be utilized for stores, and the second floor will be occupied by offices in front, with cloak rooms and a large dining room in the rear. On the top floor will be located one large and one small lodge hall with the usual accessories. It is understood that tenders for this building will be called for during January.

A permit for a two-storey and basement, brick and mill construction building to be erected at 155 Alexander street, Vancouver, for Mr. E. Cook was issued at the middle of December. This building will be used for store and office purposes, and will probably be erected by day labor. W. M. Dodd & Son, Vancouver, were the architects.

The Dominion authorities recently made an appropriation of $15,000 to be utilized in building retaining walls and doing other permanent work in connection with the two lighthouse stations which are located in Stanley Park, Vancouver. All work will be carried out under the supervision of the Vancouver Park Board.

Messrs. Sharpe & Thompson, the Vancouver firm of architects which is engaged in preparing detail plans and specifications for the proposed British Columbia University buildings at Point Grey, near Vancouver, has awarded a contract to Dixon Bros. & Shultz for clearing the site for the University, which comprises an area of about 160 acres. In a recent statement from Victoria, Hon. Dr. Young, provincial minister of education, announced that actual construction on the various buildings would probably be inaugurated immediately after the land was cleared. A preliminary appropriation of $500,000 is available for the construction work, which it is expected will ultimately represent an expenditure of several millions of dollars.

It is believed that a large number of tenders will be submitted from all over Canada for the construction of the proposed immigration buildings at the foot of Salisbury Drive, Vancouver, for which tenders closed on December 29. These buildings will be of heavy reinforced concrete and brick construction, costing about $300,000 and will be erected by the Dominion government.

Messrs. Dalton & Eveleigh, of Vancouver, are engaged in the preparation of plans for a proposed reinforced concrete warehouse to be erected for Cope & Son, a Vancouver firm of electrical contractors. While there are no building details available for publication, it is understood that the warehouse will be a substantial fireproof structure of the latest type, costing about $100,000.

Work started at the close of the year on the reconstruction of the seven-storey annex to the wholesale warehouse of Kelly Douglas & Company, Vancouver, which was recently practically destroyed by fire. The original plans of the structure will be utilized in connection with the present contract, which is in the hands of Mr. J. McLuckie, Vancouver. The new building will be of mill construction, and is estimated to cost approximately $40,000.

The proposed new fish packing and cold storage plant to be erected at Steveston (Lulu Island) for the B. C. Packers' Association of New Westminster, will be housed in a heavy mill construction building resting on concrete and pile foundations. Plans and specifications were prepared by the Linde Refrigeration Company, and the general contract recently awarded to the B. C. Granitoid Company, both of these firms hailing from Vancouver. There will be two other contracts awarded in connection with the project, one for the electrical work and another for the special machinery equipment required for a complete fish canning and cold storage plant. The capacity of the plant will be about five million pounds in the cold storage department. The total cost of construction has been estimated at approximately $200,000.

A permit was recently issued to Mr. W. Philpot for the construction of an ice-making plant on Carnarvon street, New Westminster. The factory will measure 33 x 64 feet, and will be of frame construction with galvanized iron sides and rubberoid roof. The equipment to be installed includes a 30-ton refrigerating machine, which will represent an outlay exclusive of the building, of $10,000. It is expected that active construction will be commenced before the end of January.

The Morrison Steel Wire Company, whose present factory is situated in Vancouver, recently secured a site of about 16 acres on Lulu Island, about 8 miles from the city, and announce that a factory will be erected there and the company's business transferred to the new location within the next few months.

The general contract for the construction of a two-storey brick and mill hotel building for Mr. H. C. Thornton at Port Coquitlam has recently been awarded to Mr. W. H. Mueller of Vancouver. Parr, McKenzie & Day of Vancouver, are the architects for the building, which will be entirely modern and excellently equipped throughout.

The New Sanitorium at Kamloops

It is expected that work will be started early in January on the proposed sanitorium building at Tranquilla, near Kamloops, for the B. C. Anti-Tuberculosis Society, for which plans have been prepared by Dalton & Eveleigh, of Vancouver. The building will be of reinforced concrete on concrete foundations, with sand and lime plastering. The floor of the entrance hall will be finished in terrazzo tile. Steam heating and electric lighting will be employed throughout. The equipment of the building includes galvanized iron metal work, and skylights, a telephone system and fire extinguishers.

Work was started recently on the new Enderby Armory, for which the general contractor is Mr. J. Russell, a local builder. The building will measure 42 x 93 feet, and will have a solid concrete basement and two upper storeys of brick construction. The basement will contain a 60-foot shooting gallery and furnace room. The main hall measures 40 x 60 feet by 16 feet high, with truss roof covered with galvanized iron shingles. In the rear of the main hall will be six rooms, each measuring 14 x 24 feet for officers' quarters, two armories and a store room, all floors to be solid concrete, covered with No. 1, 1 x 3 flooring. There will be one furnace in the basement, and two in the main hall, and for fire protection, two hydrants, each with a 50-foot length of hose attached, will be placed in convenient positions. The cost of the building will be between fifteen and sixteen thousand dollars.

It is the intention of the Nelson City council to shortly submit a by-law to the ratepayers for an additional $20,000 to be used for the construction of the proposed new Nelson Hospital. The provincial government will also be asked for a grant of $50,000, which if supplied, will provide a total of $90,000 for construction purposes.

Messrs. H. P. Leake and W. A. Calder were recently awarded the contract for a new wharf which the Dominion government is erecting at Kaslo, B.C., at a cost of $135,000.

The ratepayers of Nelson recently endorsed a by-law for the purchase of the street railway system which has been operated for a number of years past by a private company, thus again demonstrating their support of the principle of municipal ownership. The city now owns its own waterworks system, a 3,000 h.p. hydro-electric plant, and recently purchased the gas plant, which had been operated as a private enterprise for the past ten years.

Subject to revision by the 1914 council, the following work is provided for in a by-law to be submitted to the ratepayers of Vancouver in January, 1914:Grading for sidewalks, $50,000; grading streets, $110,000; grading lanes, $26,000; culverts and bulkheads, $10,000; rocking streets, $96,000; planking streets, $47,000; rocking lanes, $41,000; planking lanes, $30,000.

The Prince Rupert city council has given first reading to by-laws for municipal works to be voted upon at the coming civic election. The amounts provided are as follows: Telephone extension, $70,000; permanent building, Fulton street, $50,000; recreation grounds, $30,000; extension of electric light plant, $45,000; new electric light plant, $105,000; municipal waterworks extension; agreement with Prince Rupert Hydro-electric Company.

Following the recent announcement of Mr. H. H. Stevens, M.P. for the city of Vancouver, to the effect that Dominion Public Works Department, is now working on plans involving the construction of extensive harbor works at Kitsilano Reserve, comes the news that the Vancouver civic officials are contemplating the erection of a bridge spanning False Creek from the reserve to the foot of Burrard street on the opposite side. While the scheme is as yet in tentative form it is recalled that the city has had this project in view for the past two years, and there appears to be every likelihood that the question of a bridge at this point will be seriously considered in the near future. With reference to the Kitsilano project, the only information that is available at present is contained in the statement by Mr. Stevens that the work will be on a large scale involving an expenditure of millions of dollars, embracing railroad trackage, warehouses, docks, etc., and probably necessitating additional dredging operations at the mouth of False Creek. It is expected that an appropriation bill in connection with the scheme will be presented at the next session of the federal parliament.

The annual report of Municipal Engineer Clement, of South Vancouver (who has recently tendered his resignation), shows that the following work was carried out during the year 1913: Streets cleared and rough grades, 3.235 miles; streets graded and bulkheaded, 12.297 miles; streets macadamized, 2.98 miles; streets permanently paved, 3.841 miles; streets oiled, 15.428 miles; plank roadway laid, 4.302 miles; box drains laid, 3.203 miles; walks laid, 9.127 miles.

Plans for the proposed Canadian Northern Pacific Railway bridge to be erected across the Victoria Arm from the Gorge Road to Songhees Reserve, at Victoria, have been filed with the Dominion government authorities for approval. The company's plan shows the location of the proposed bridge at about 200 feet above Dead Man's Island, with a 60-foot bridge bascule type, spanning the channel west of the Island, and a 25-foot opening adjoining the main span. The fill would run 1,110 feet in a southerly direction from the Gorge Bridge, the balance of construction to be of ordinary pile trestles with bents fifteen feet apart.

In the Supreme Court at Vancouver, Judge Grant recently handed down an important judgment effecting subcontractors' claims under the mechanics' lien act. His Honor's finding makes it feasible for any sub-contractor who has paid up all his workmen and all his bills for material, to make and maintain successfully a claim against the owners of the building, works or improvements undertaken for the amount due him under the mechanics' lien act.

The city council of Vancouver, at a special session recently authorized a by-law providing $14,000 for the erection next year of a fire hall at some point in Hastings Townsite yet to be selected. Of this amount $10,000 will probably be spent for the building, and $2,000 for the site.

It is considered unlikely that there will be any new school construction undertaken by the Vancouver school board during 1914. Aside from the amounts which will be required for the purpose of making a few small additions to existing buildings the members have decided to submit no money by-laws for the coming year excepting those covering regular expenses.

Contract Let For New Drill Hall at Victoria

Advices from Victoria state that the Dominion Department of Public Works has awarded the contract for Victoria's new drill hall to Parfitt Bros., of Victoria, who intend to commence constructional operations before the end of January. The building is to be of red brick faced with cut stone and battlemented, and will be erected on a site bounded by McBride street, Bay street and Field street, with the main entrance on Bay. This entrance will be in the form of a handsome gateway under a square tower, in the centre of the building. The main hall will be spacious affair, measuring 100 x 200 feet.

In the tower, accommodation will be provided for bands, and on either side of the entrance are rooms for the commanding officers and adjutants of two regiments, and in the left wing similar rooms for the officers of a third regiment. On the right front is a room for the British Campaigners, and at the rear of the hall offices for the brigadier and his adjutant. Armories, gunsheds and stores occupy the remainder of the ground floor, while underneath in the basement is the ambulance store, access to which is gained by an inclined roadway. In the basement, too, is the regimental swimming bath.

On the second floor are the four officers' messes and kitchens, sergeants' messes and reading rooms for the men, and above these again three suites for caretakers, comprising four bedrooms, sitting room and kitchen.

The contract calls for the completion of the whole building within eighteen months. Major W. Ridgway Wilson, of Victoria, prepared the plans for the new drill hall which it is understood, will be the second largest in Canada, being exceeded in size by only one other building of this type, namely that at St. Johns, N.B. The cost of the work will be approximately $240,000.

Victoria's Good Prospects

Commencing operations at the middle of January, the seating capacity of the Princess Theatre in Victoria will be enlarged from 600 to 1,000 the work practically involving the reconstruction of the entire building. The house will be closed for a period of two months during which the back, front and east side walls are to be demolished and the structure transformed into an up-to-date theatre at a cost of approximately $35,000.

Tenders covering the separate contracts required in the erection of the new store building for the Hudson's Bay Company at Victoria closed on December 27. The plans provide for a ten-storey structure, but it is intended to erect only four storeys at the present time. The amount available for construction work is $450,000.

Messrs. Coates & Fleet, recently completed plans for extensive alterations to the Brown Jug Saloon in Victoria, which will transform the present quarters into a modern hotel. The ground floor of the altered premises will be occupied by the buffet, dining room, office and other departments, and the two upper floors will accommodate over 30 rooms fitted up in attractive style. It is intended to install a complete system of steam heating. The Victoria firm of Metzger & Weston will handle the general contract, which is valued at approximately $25,000.

Tenders closed at Ottawa on January 8 for the construction of two reinforced concrete piers with a solid fill in Victoria harbor, for which the Dominion Department of Public Works has made a preliminary appropriation of $500,000. The ultimate expenditure on the piers, of which there will eventually be four, will be $750,000 each. It is understood that a number of the large construction companies throughout Canada have submitted tenders for the contract.

It is understood that McCutcheon Bros., realty dealers of Victoria, have purchased the premises at 844 Fort street, where it is their intention to erect a store and office block in the near future. The lot occupies a street frontage of 60 feet, and cost $60,000.

Credence is being given a report circulating at the Coast that the Dominion government will probably make provision in next year's estimates for the construction of a new court house in Victoria. A triangular block, comprising an area of two-thirds of an acre, and bounded by Blanchard and Collinson and Burdette streets, which was recently purchased by the authorities, is reported as the proposed site of the new building.

A two-storey frame apartment block with accommodation for 36 rooms will shortly be erected for Mr. F. Fairhurst on the corner of Queens avenue and Vancouver street, Victoria, at a cost of about $20,000.

Within the near future the Dominion government will call for tenders for the execution of extensive improvements on the Victoria post office block. The plans, which were prepared some time ago, have been revised, and it is reported that they are on the point of completion. It has been announced that the new plans provide for two extra storeys at the rear of the present building, instead of one, as was originally proposed.

The Victoria city council recently adopted a resolution to the effect that the debentures authorized under the $80,000 by-law passed last January for the erection of a new jail be issued and placed on the market at once, and that plans and specifications be prepared and tenders called for the new structure forthwith.

The annual meeting of the Canadian Society of Civil Engineers will be held at Montreal January 27, 28 and 29.

"The Engineer's Part in the Regulation of Public Utilities" was the subject of a discussion at the Stevens Institute of Technology, Hoboken, N.Y., on January 9.

During the year just closed, three-quarters of a million dollars have been expended on the roads of Ontario. The year's work on highways improvement shows 220 miles of highway added to the transportation facilities. The style of road is macadam and gravel, of a type which is giving satisfaction to the Provincial Highway Engineer, Mr. W. A. McLean. The share borne by the government in the construction and supervision of the work is one-third.

The Concrete Machinery Company, Limited, is to be the new firm name of an amalgamation of the Woodstock Wind Motor Company and the Mitchel Crusher Manufacturing Company, the latter of which is a selling organization for stone-crushing machinery, with headquarters in Toronto. A by-law upon which the ratepayers of Woodstock are asked to vote provides for the loan of $20,000 to the Concrete Machinery Company. As security the company is to give the corporation of Woodstock a first mortgage on all its real estate, building and machinery.

Personal Mention

Mr. J. C. Stewart has received an appointment as manager of the Toronto Wire Nail & Tack Company, West Toronto.

Mr. A. R. Woolridge, manager of the scale department of the Canadian Fairbank Morse Company, Toronto, has left for a short holiday at his Texas home.

Mr. C. J. Simms, assistant engineer of the Saskatchewan division of the Canadian Pacific Railway, has been transferred to Vancouver to succeed Mr. H. B. Walkem as assistant division engineer.

Mr. G. Janin, chief engineer of the city of Montreal, has withdrawn his application for a pension of three-quarters of his salary. A bill to grant this higher pension was introduced into the Quebec Legislature.

Mr. H. V. Armstrong has returned to Estevan, Sask., as town engineer. A graduate in civil engineering of Toronto University, Mr. Armstrong spent over four years in Estevan supervising the new water supply and sewage disposal system, etc.

Mr. W. A. Clement, of South Vancouver, B.C., has been appointed chief engineer for the district of South Vancouver, and will have charge of pavement, road and drainage construction. Mr. Clement was assistant city engineer of Toronto from 1898 to 1905, and city engineer of Vancouver from 1905 to 1911.

Mr. I. Feldman, architect, who was associated for some time with Mr. J. P. Hynes, 199 Yonge Street, Toronto, has opened an office at 44 Adelaide West. Mr. Feldman has several projects already in hand, including the Collett Sproule factory on Portland Street, and the Rotenburg warehouse on Elizabeth Street.

Mr. H. B. Walkem, for five years Assistant Divisional Engineer of the Canadian Pacific Railway at Vancouver, has been appointed engineer in charge of the Kootenay and Boundary districts of that road, with headquarters at Nelson, B.C. Mr. Walkem has had thirty years' experience in railroad engineering in the Pacific province.

Mr. Charles P. Dubuc, B.A.Sc., in conjunction with his brother, has commenced business as a consulting engineer, under the firm name of Dubuc & Dubuc, in the Canadian Express Building, Montreal. Mr. C. P. Dubuc has been connected with municipal works in St. Louis, Cote St. Paul and Maisonneuve. He has also had experience in hydrographic work and good roads promotion.

Mr. Beaudry Leman has been appointed general manager of the Hochelaga Bank, Montreal. Mr. Leman is a civil and electrical engineer and at one time was a member of the Montreal Electrical Service Commission. In 1906 he was in charge of the construction work of the Shawinigan Water and Power Company, and later organized the Canadian General Development Company, which was interested in electrical enterprises. In 1912 he entered the banking business.

Mr. Reginald W. Brock, director of the Geological Survey of Canada, has been appointed Deputy Minister of Mines in succession to Dr. A. P. Low, retired. Mr. Brock was born in Perth, Ont., in 1874, and was educated at the Ottawa Collegiate Institute and Toronto, Queen's and Heidelburg. As a professor at the Queen's School of Mines before joining the staff of the Geological Survey he carried out many important explorations and is regarded as one of the best geological authorities in Canada. He has been Director of the Survey since 1904.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The building permits taken out at Brantford, Ont., during 1913 totalled in value $1,015,886, a decrease of $151,219 on the previous year's total.

Mr. J. T. Blyth, heating and sanitary engineer, has secured the contract for the plumbing and heating work in a number of new buildings in Ottawa, including the Blackburn Building and St. Lukes' Hospital.

Notwithstanding the much-talked-of hard times, the building permits issued in Fort William show an increase of over a quarter of a million dollars, the respective figures being: 1913, $4,029,965, and 1912—$3,746,565.

Gypsum is regarded as one of the leading industries from the point of view of exports in Hunt's County, N.S. Last year the total exports amounted to 260,000 tons, but this year the total will reach fully 300,000 tons.

As previously announced in these columns, Messrs. Roger Miller & Sons are the contractors for the laying of about 4,000 feet of pipe, including tunnel and reservoir connection, tanks, etc., on Toronto Island. The work is progressing rapidly.

According to the city architect plans were endorsed in Toronto during 1913 for 9,877 buildings at an estimated cost of $26,962,654, as against 10,217 buildings at a cost of $27,401,761 for which permits were issued in 1912, the latter being a record year.

It is announced that the contract for the new factory for the Canada Nail & Wire Company, which is to be located at Cold brook, about three miles from St. John, N.B., will be awarded as soon as the company has received its charter. The construction will probably be of brick.

Returns issued from Port Arthur show that for the past year the amount of building done in that city is valued at $1,935,680, as compared with $2,494,179 in 1912. Explanation of this decrease is that the permit for the new government elevator, which cost a million and a half dollars, was issued in December, 1912.

Welland has just emerged from a year of great prosperity in building construction. It is stated that two miles of brick pavement, half a mile of slag and macadam pavement, one and one-half miles of sewers and four and one-half miles of cement sidewalks have been laid, the total building for the year 1913 amounting to $1,061,157.

Plans are being prepared at Windsor, N.S., for a modern mill, with a capacity of 250 barrels a day, for the manufacture of plaster products. The company, with a directorate consisting of Messrs. Rufus Curris, of Windsor; Hon. A. K. MacLean, M.P., T. F. Courtney, Gerald B. Ternan, and F. C. Smythe, all of Halifax, was formed last year and it is anticipated that the new mill will be ready for work next summer.

The firm of McAvity & Sons, Limited, St. John, N.B., are contemplating the erection of an extensive range of buildings to consist of a warehouse, iron and brass machine shops, power house, foundries and administration building. All the buildings are to be of steel and brick, with concrete foundations. When completed the proposed plant is expected to furnish employment to twelve or fifteen hundred people. It is expected that tenders will be called early this year for the greater part of the work.

During 1913, 287 permits were issued by the Building Inspector's Department at Welland. These were of the total value of $611,157; $398,455 representing 237 permits were for residences, and $212,702 representing 50 permits, were for business and public buildings. In addition to this $350,000 for industries and $100,000 for residences was spent on the industrial section outside the town limits, the total for the year being $1,061,157.

According to a Fort William despatch, the stocks of cement available at that point are much lower than at the corresponding period a year ago. If last year's activity in building operations is repeated this year it is feared that there will be a shortage of cement in the spring. It is stated that owing to the loss occasioned by the big storm on the lake in November, when thousands of sacks of cement were lost, manufacturers were deterred from shipping any more cargoes until the spring.

The Sherbrooke Tile & Brick Company has been incorporated with a capital stock of $75,000. Its head office will be in Sherbrooke, Que., and the business to be carried on will include the manufacture of brick, tile and clay products of all kinds. The promoters are Messrs. N. N. Walley, C. Beauchesne, N. E. Walley, Chas. B. Howard and J. MacDonald, of Sherbrooke, and E. L. Darche, of Ascot Corner. The new company has purchased the Ascot Brick plant, owned and operated for many years by D. G. Loomis & Sons.

The building permits issued in St. John, N.B., last year amounted to nearly $2,500,000, or about $2,000,000 more than the value for 1912. Work on some of the large contracts begun last year will be continued in 1914, and the prospects for new building projects are considered bright, for the reason that greater housing accommodation must be provided for the people. Mr. D. F. Pidgeon, who has lately returned from a trip to Great Britain, brought the information that the organization of a large building company to erect dwellings in St. John and its neighbourhood is making good progress. It is known that local companies will also take a hand in construction work, and therefore 1914 should prove a good building year in St. John.

WESTERN CANADA

New Westminster's building permits for 1913 amounted to $958,975, as compared with $1,634,518 in 1912 and $1,124,587 in 1911.

The new Government wharf at Argenta on the Kootenay Lakes is rapidly nearing completion. The docks are of a new type of construction and an innovation in British Columbia.

Last year the building permits issued at Prince Albert, Sask., amounted in value to $1,380,290, as compared with $2,042,450 for 1912. The figures are from Mr. H. L. Fitzsimmons, Building Inspector.

Mr. J. S. MacLachlan, Dominion District Engineer, has returned from a tour of inspection of the harbor works in the Nanaimo district, B.C., during which he investigated the dam age done by the recent heavy gales. He found that repairs were necessary at Sydney Island where the wharf had been considerably damaged. Repairs will also be necessary at Sydney, Metchosin and Rocky Point.

Work on the Government docks on the Arrow Lakes is progressing rapidly. This work includes new docks at West Damars, East Arrow Park, Needles and Renata, all of which are floating docks.

According to figures furnished by Mr. O. T. Falls, building inspector at Regina, the permits issued in that city last year amounted in value to $4,018,350. This compares unfavorably with the 1912 total of $8,047,309.

The aggregate value of buildings started and for the most part completed in Saskatoon during the year 1913 was $2,633,845. The greatest number of permits issued and value of buildings planned was in the month of May, the falling off taking place since August.

The city of Medicine Hat has established a record in the number of building permits issued during the year. The building inspector, Mr. Daley, reports that permits have been taken out for buildings valued at $3,851,572, an increase of $1,015,353 over that of 1912, or over 40 per cent.

One of the most important civic buildings to be erected this year is the Central Police and Fire Station, at the corner of Elizabeth and Fraser Avenue, Edmonton, Alta., at an approximate cost of $350,000. The plans and specifications were prepared in the office of the City Architect, Mr. A. M. Jeffers. The new building will be constructed of pressed brick with stone trimmings. About two-thirds of the structure will be occupied by the police department.

A decision that will interest architects was given on January 1 at Regina, by Mr. Justice Elwood, when the claim of Messrs. Munro & Mead, architects, against the Yorktown Agricultural & Industrial Association, Limited, for service in preparing plans for a grand stand was allowed. The plaintiffs had prepared two sets of plans, the stand to cost not more than $14,000, but tenders were considerably higher on both occasions and the defendants decided not to proceed on the work, declining to pay for the plans. Plaintiffs were awarded $680, made up of $490 for the first set of plans, $180 for the second set and $10 for taking out the permit.

A remarkable suspension bridge has been erected by the Indians in British Columbia, across the Bulkley River, Prince Rupert. A feature of the bridge is the almost total absence of nails. Joints were made by dove-tailing and burning a hole with red hot coals through the two logs into which a stout wooden spike was driven, the joints being then bound with wire. The big cable supporting the structure was obtained from the Hudson's Bay Company, who used it on the first steam boat which travelled up the stream.

Obituary

Mr. Benjamin Goldthorpe, a former Toronto contractor, passed away recently at Hamilton.

Mr. James Steele, president of the James Steele Wire Works, Limited, Guelph, Ont., died on December 30.

Mr. Alfred Williams, formerly associated with Mr. M. J. Haney in the construction of the White Pass and the Cooper River and North Western railroads, died recently.

Mr. Lockie McQuarrie, of New Westminster, one of the best known contractors and financiers in British Columbia, died recently at San Diego, Cal., at the age of eighty years. The late Mr. McQuarrie was the pioneer road contractor of the province, having carried out several contracts on the Canadian Pacific Railway main line and constructed the first twenty-five miles of the Great Northern Railway at New Westminster.

Canadian Railroad Development

Mr. B. B. Allither, Chief Engineer of the Grand Trunk Pacific, announced recently that the line would be completed next April at a point about a hundred miles west of Fort George, B.C.

Mr. A. R. Gould, president of the St. John Valley Railway, recently secured a charter for a railway across the northern part of the state of Maine, connecting the existing lines in Quebec and New Brunswick.

The Lake Erie & Northern Railway is seeking power to increase its issue of securities from $30,000 to $45,000 a mile and to borrow money and issue securities for the acquisition, construction and extension or development of any properties or works other than railway.

Sir Wm. McKenzie, president of the Canadian Northern Railroad, announced recently that the company had decided upon an expenditure of about $10,000,000 in securing additional rolling stock for the operation of this road. It is stated that practically the entire amount will be laid out between Toronto and Port Arthur. Sir William further stated that as a result of the opening of the new transcontinental line, Leaside will become one of the largest repair shops on the road.

As part of the Canadian Northern Railway extension in Nova Scotia it is said to be the intention of the company to establish a junction at a point convenient to Sydney and Louisburg, with pier terminals at both places. Sydney will be the summer terminal and Louisburg the winter terminal of the Canadian Northern, with a transcontinental branch running from the strait to Moncton along the Northumberland short route to Moncton, and thence west by the best available route.

A report from Sydney, N.S., states that Messrs. Mackenzie and Mann, who own the Inverness railway, will negotiate for a right-of-way from St. Peter's to Sydney, a plan which includes the taking over of the Vanderbilt-Webb line, Point Tupper to St. Peter's, and the extension from St. Peter's to Sydney and St. Peter's to Louisburg, by way of the South Cape Breton route. It is understood that the Canatian Northern is willing to commence the work as soon as the right-of-way can be secured and the construction financed.

Sir. Wm. McKenzie, president of the Canadian Northern Railway, drove the last spike of the new line connecting the eastern and the middle western provinces of Canada near Little White Otter river, at a point 254 miles east of Port Arthur, 616 northwest of Toronto and about 60 miles north of White River station, on January 1. This gives the country its second cross-continent line from Quebec to British Columbia. This new section of the line when fully completed will be remarkable for the rapidity of its construction and for its efficiency. The contract was awarded to Messrs. Jones Bros. and the Northern Construction Company in the summer of 1911. Mr. H. K. Wicksteed was chief locating engineer.

Construction work on the Edmonton & Dunvegan Railway is making satisfactory progress. The first one hundred and thirty miles will be over that portion already constructed which brings the end of steel to Smith and the south bank of the Athabasca river. Grading on the new line has been done to mile 220 and surveys are completed for 210 miles. Extensive orders for rolling stock were placed some time ago with the Canada Car Company, of Montreal, including eight locomotives, one hundred box cars and fifty flat cars. Mr. W. J. Pace the newly-appointed superintendent of construction for both roads, is well known in Edmonton as a pioneer in railway work into that city and as a commissioner of public works.

Souvenir of Royal Visit to Pilkington Plant

In July of last year Their Majesties the King and Queen, while touring the northern industrial district of England, paid a visit to the great glass works of Messrs. Pilkington Brothers at St. Helens, Lancashire, and an interesting souvenir booklet has been issued by the firm as a memento of the occasion. By those who wish to know something about glass manufacture this publication will be found particularly instructive. The illustrations carry one through the principal departments of the largest glass-manufacturing establishment in the world—an industry whose products have found their way into every country. It may be of interest to note that the business was founded in a small way in 1826 by Richard and William Pilkington and that at present three generations of the family are actively engaged in the management. The firm have made an aggressive bid for Canadian business, having established warehouses at Montreal, Toronto, Winnipeg, Calgary and Vancouver, and built a factory at Thorold, Ont.

Brownhoist Hand-Travelling Cranes

Illustrated herewith is the Brownhoist Single I-Beam Hand-Travelling Crane manufactured by the Brown Hoisting Machine Company, Cleveland.

The construction of this crane permits it to be used in very limited head-room. The crane consists of a single I-beam supported at each end on a Brownhoist patented truck-frame of cast steel. The I-beam is of standard size, sufficient for the required capacity and span. The lower flange of the I-beam serves as a track for the trolley with the load, as shown in Fig. 1. The patent truck-frame (Fig. 2) is a one-piece steel casting of light construction but with ample strength for the crane capacity. It is so designed that there are no undue strains put upon any member and the load is distributed equally of the two truck wheels. The I-beam rests on two planed surfaces at the centre of the truck-frame. It is bolted to the truck-frame at the top (Fig. 2) and is also held in place by a dowel on the truck-frame which fits into a small recess on the underside of the bottom flange of the I-beam. By means of this simple construction, the crane is erected easily and quickly, even in close quarters.

The truck-frame is supported on two truck wheels with a bearing on each side of the wheel. The two bearings with the axle and wheel are secured to the truck-frame by means of U-bolts. The cranes of ¼ to 1-ton capacity inclusive are fitted with bronze bushings which are scored to give the proper lubrication to the bearings. The larger size cranes, above 1-ton capacity, are bushed with steel roller-bearings. These reduce to a minimum the wear on the axle and make the operation of the crane very much easier. By having a bearing on both sides, the wheel is kept in an erect position, regardless of any wheel-flange side pressure. It permits small diameter axles to be used, which results in a very low frictional resistance when the crane is travelling. Also it distributes evenly the wear on the bearings. Each crane is equipped with a squaring shaft connecting one wheel of each truck (seen Fig. 1). This insures uniform travel of both end truck-frames. All standard cranes of ¼ to 1-ton capacity inclusive, with spans not exceeding 20 ft., have no travelling mechanism. These cranes are easily propelled along the track by pushing or pulling on the load. The larger capacity cranes are equipped with hand travelling chain and sprocket wheel (Fig. 1). By pulling on the hand-chain, the crane is propelled along the runway. The largest capacity cranes are fitted with travelling reducing gears which reduce the amount of pull required on the hand-travelling chain necessary to travel the crane.

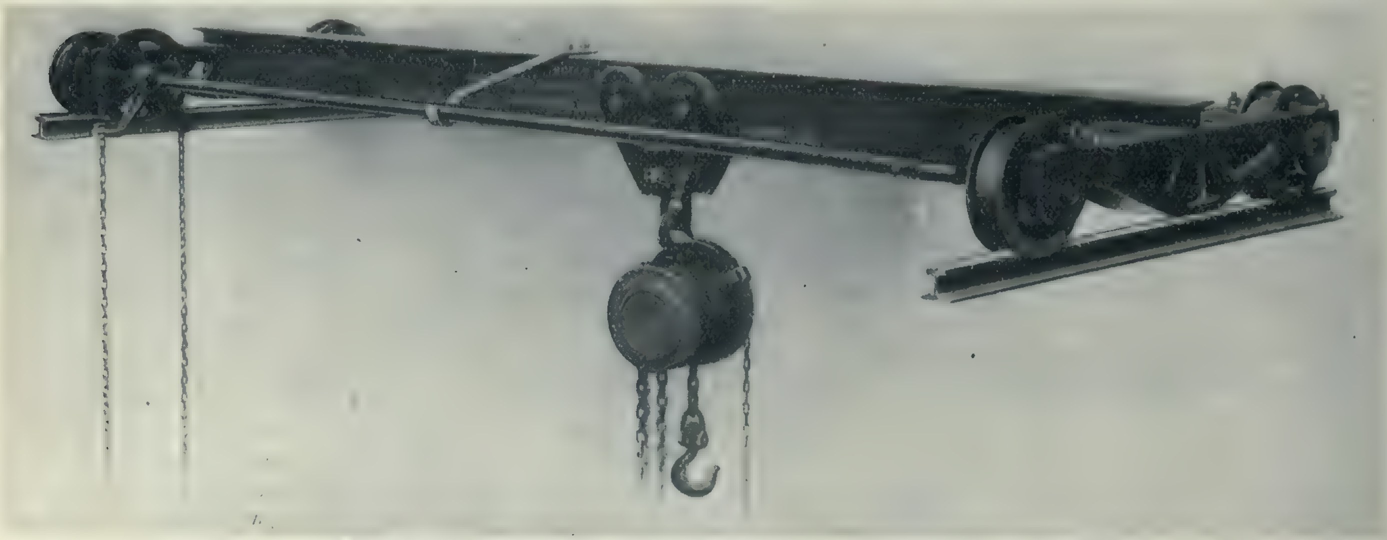


Fig. 1—Brownhoist single I-beam hand-travelling crane with patented cast-steel ends, equipped with a Brownhoist trolley and a Yale & Towne triplex chain block.

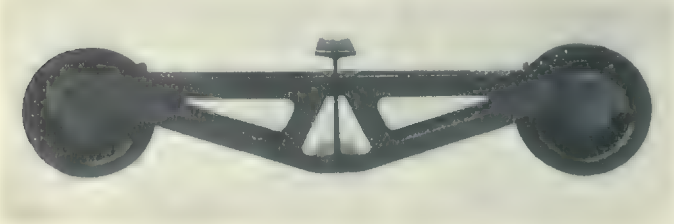


Fig. 2—Brownhoist patented cast-steel end.

A joint conference of representatives of the City Council, Board of Trade, Harbor and Navigation Committee and Inner Harbor Association, met in Victoria, B.C., recently to examine the plans for the proposed Canadian Northern bridge across Selkirk water. The feeling was against a temporary structure being allowed, and that in any event a pile or trestle structure should not be allowed to be used more than three years. Messrs. J. S. MacLachlan, Dominion Resident Engineer, and D. O. Lewis, District Engineer of the province, were among those present.

Late News and Industrial Notes

Messrs. M. D. Seaman & Son, Sauble Falls, Ont., intend going into the manufacturing of sand-lime brick, the timber on their limits being practically exhausted.

The publicity commissioner of Fredericton, N.B., states that two new mills will be erected there in the spring, and that several other concerns will enlarge their plant.

Work on the construction of the new British Columbia offices in London, Eng., has been commenced by the contractors, Messrs. Hannin & Cubit. The site, which is on Regent street, is Crown property and the total cost of construction will approach $300,000.

The Burrard Inlet Tunnel & Bridge Company, in order to facilitate matters in connection with the Second Narrows Bridge, B.C., will call for tenders for the new bridge on plans prepared by Sir John Wolf Barry and his associates, tenders to be in by April 1.

Mr. A. E. Allison, one of Winnipeg's old-timers, is at present engaged at Indian Bay, Lake of the Woods, in building temporary camps for the Greater Winnipeg water project. Mr. Allison is one of the oldest railway and building contractors in the west, he having been engaged in that work since 1877.

Various kinds of elevated steel tanks built for municipal service are described in an informative, well-illustrated catalogue received from the Chicago Bridge & Iron Works, Chicago. The booklet is made additionally interesting by the tables which it contains and an outline of the proper method of finding stresses in the various parts of the structure.

Addressing the Vancouver Chapter of the British Columbia Society of Architects, Mr. H. H. Stevens, M.P., alluding to the powers possessed by the architects' profession said that in no other calling could a man do so much good for humanity and likewise in no other profession could he do so much harm if one allowed mercenary considerations to run away with his sense of right.

A report from Vancouver states that Mr. A. F. Yarrow, head of a great ship-building firm operating on the Clyde, has bought out the British Columbia Marine Company with the intention of establishing a branch of his yards at Esquimalt, for shipbuilding purposes. He is said to be influenced in deciding in favor of Esquimalt by the fact of the government drydock being located at Langs Cove.

Messrs. F. H. Hopkins & Company, Montreal, manufacturers of railway, contractors' and mining supplies, have favored us with one of their calendars for 1914. The numerals are in good plain type and the calendar is particularly valuable for office and warehouse purposes. We are also indebted to The B. Greening Wire Company, Limited, Hamilton, for a most serviceable calendar.

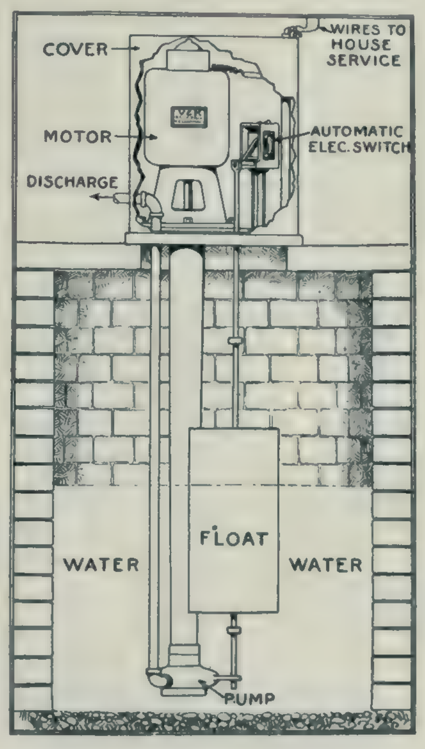
The record of buildings in Victoria for the past year has been satisfactory in view of the adverse financial conditions. The number of permits issued was 1,157, as compared with 1,763 the previous year. The total value for 1913 was $3,766,230 apart from additions to the Parliament Buildings, Post Office, and a new theatre which totalled about a quarter of a million. The total value of permits issued in 1912 was $8,060,170.

Addressing the British Columbia members of the Canadian Society of Civil Engineers at the second annual convention dinner in Victoria, Hon. W. R. Ross, Minister of Lands, referring to the natural resources of western Canada said the engineering fraternity bore an important relation to the development of these natural resources. Almost the entire success in many lines depended on the economics of engineering and he felt that the men of that profession knew their responsibility and would rise to the occasion and do as well by British Columbia as nature had done by the province.

The St. John, N.B., city council has asked the Dominion Government to move back the railway trestle which now crosses the area, dredge out the basin, and construct two steamship berths, eight hundred feet in length, on the site adjoining the wharf of the new sugar refinery. The railway could be carried around the shore instead of crossing the basin on a trestle as at present, and the change would also involve the removal of some small factories, some fish-curing houses, a coal depot and other buildings. The Federal Government owns nearly all of the property involved, and the proposed two steamship berths are greatly needed on the eastern side of the harbour.

Automatic Electric Cellar Drainer

Those who are troubled with wet cellars or basements will appreciate the value of the automatic electric cellar drainer illustrated herewith. This device, it is claimed, is the first practical drainer of moderate price suitable for private residences, apartments, elevator pits, etc. As shown by the diagram it consists of a centrifugal pump direct connected to a vertical Westinghouse motor. The pump is installed in a three-foot well into which the seepage drains, the motor and control apparatus being at the floor level where it is accessible for inspection and is out of the way of dampness. A float plays between between two stops on a vertical rod that is connected with the motor control switch. When the water in the well rises sufficiently to cause the float to press against the upper stop, the motor is started and continues in operation until the water level is lowered so that the float presses against the lower stop, when the current is cut off. The seepage is thus cut off without attention, an occasional inspection and lubrication being all that is required. This pump has a capacity of 500 gallons per hour against a head of 5 feet, and 150 gallons per hour against a head of 20 feet. To install it all that is necessary is to provide a well three feet deep, place the pump, and make the electrical connections. It operates from the electric lighting circuit.



Motor-driven pump for draining purposes.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Coteau Station, Que.
Tenders for laying cement sidewalks will be received by Secretary of Municipal Council, G. E. Andre, until noon, Jan. 19th.

Dereham Twp., Ont.
Surveys for a tile drain have been made by the engineer-in-charge, F. J. Ure, Woodstock.

Le Pas, Man.
The necessary by-law having been passed by the ratepayers, tenders will be received by Secretary to Town Council, H. H. Elliott, M.D., until 6 p.m. Feb. 3rd, for the construction of approximately 430 ft. of 16 in. supply intake main and 2 sewer outlets into the Saskatchewan River. Specifications and plans at office of Consulting Engineers, Murphy & Underwood, Saskatoon, or with Resident Engineer, Le Pas.

A by-law providing for the installation of waterworks system was passed by ratepayers Dec. 16th.

Kenora, Ont.
The by-law to raise $22,000 for improvements to roads and $3,000 for parks has been carried by the ratepayers. The council will probably purchase a steam road roller.

Lumby, B.C.
Municipal Council have under consideration the installation of a waterworks system and a committee of three (J. T. Bardolph, C. Quesnel and T. A. Norris) has been appointed to look into the matter. Water will probably be brought from Harris Creek.

Niagara Falls, Ont.
Plans are in progress for the laying of 3,000 ft. 24-in. storm sewer from Third Ave. to Victoria Street.

The by-law to raise $5,000 for storm sewer on 3rd Ave. and Maple St., was carried by ratepayers Jan. 5th.

Norwich, Ont.
A by-law authorizing the expenditure of $25,000 on the installation of a waterworks system was carried by the ratepayers on Jan. 5th.

Ottawa, Ont.
Plans have been drawn for asphalt pavement on Parent Ave. from Clarence St. to St. Andrew, tenders for which are to be called in spring. Estimated cost is $8,000.

Surveys have been made for asphalt pavement on Wellington street between Holland Ave. and city limits. Estimated cost $31,000.

Surface drainage having been completed, City Engineer, Arch. Currie has made surveys for asphalt pavement on Rochester St., between Ellen St. and G. T. Rly. tracks, and between Somerset and Wellington Sts.; on St. Andrew St., between Cumberland and King Sts.; and on Church St., between King Edward Ave. and Rose St. In addition to this work plans have been made for asphalt pavement on Wellington St., between Broad and Viaduct Sts., the estimated cost is $12,000.

Owen Sound, Ont.
The ratepayers defeated on Jan. 5th the by-law for roads improvements.

Peterboro, Ont.
Nothing further will be done with reference to the sewage disposal plant until after first meeting of new council to be held about the 12th inst. Chairman Board of Works, Wm. Buller. Engineer, R. H. Parsons.

Paisley, Ont.
The by-law to raise $10,000 for extension to waterworks was defeated by the ratepayers.

Point Edward, Ont.
The by-law authorizing the raising of $20,000 for the installation of watermains has been carried by ratepayers.

The Town Council has under consideration the laying of cement walks at an estimated cost of $7,000.

Regina, Sask.
It is estimated that 920,000 sq. ft. of concrete sidewalks and 23,000,000 sq. yds. of pavement are to be laid this year. Engineer, F. McArthur has the plans in progress.

Toronto, Ont.
Tenders for the construction of sewers on Benson, Boon, Day, Earlscourt, Fir, Goodwood, Harvie, Hope, Ryerson, Sellers, Sparkhall and Wade streets and four lanes.

Tenders for street grading on Ardagh, Colina, Connelly, Hallawell, Minto, Mann and Spring streets, close Jan. 20th.

Tilbury, Ont.
The by-law to extend watermains 6,000 ft. has been carried by the ratepayers.

Whitby, Ont.
The by-law authorizing the expenditure of $115,000 for installing a sewerage system was carried by the ratepayers on Jan. 5th.

Railroads, Bridges and Wharves

Esquimalt, B.C.
The Dom. Govt. Dept. of Public Works has purchased a site on Langs Cove for drydock purposes. Tenders will be called shortly.

Halkirk Twp., Ont.
The C. N. R. has been authorized to construct a bridge across Bears Pass, Con. 3, Twp. Halkirk, Dist. Rainy River, Ont., mileage 210.6 from Port Arthur.

Halifax, N.S.
It is understood that the Government may build a dry dock similar to the one now under construction at Levis, Que.

London, Ont.
The C. P. R. has been authorized to reconstruct a bridge, No. 5, across Oxford street.

Montreal, Que.
Canadian Pacific Railway have under consideration alteration and additions to Osborne St. station; these include an underground baggage room. The estimated cost is $1,000,000. Architect, Mr. Ellingwood, Windsor Station.

Mount Forest, Ont.
The by-law providing for the construction of a bridge over Maitland river to the mountain property has been passed by the ratepayers.

Niagara Falls, Ont.
The G. T. Rly. will probably construct a siding for the Standard Crushed Stone Co.

Sarnia, Ont.
Plans are in progress by the G. T. R. for reconstructing wharf. The work, which it is estimated will cost $10,000, will be started in the spring under the superintendency of W. R. Davidson, London.

Sherbrooke, Que.
The C. P. Rly. has been authorized to construct bridge No. 7 across Wellington St.

Vancouver, B.C.
Tenders received by the Burrard Inlet Tunnel & Bridge Co., 142 Hastings St. W., Secretary, K. J. Cockrell, until noon, April 1st, for construction of bridge to connect city of Vancouver with municipality of North Vancouver by means of a single line of steam track, 2 lines of electric car track, 2 lines of roadway and a footway, together with the necessary approaches thereto, as well as the machinery for working the opening span of the bridge and other incidental works. Plans, specifications, etc., at offices of Consulting Engineers, Sir John Wolfe Barry, Lyster & Partners, 2 Queen Anne's Gate, Westminster, London, Eng., at office of company's agents, Messrs. Pringle & Guthrie, Citizen Bldg., Sparks St., Ottawa, after Jan. 19th, and at office of Engineers, Messrs. Cleveland & Cameron, after Jan. 26th.

CONTRACTS AWARDED

Kincardine, Ont.
The Dom. Govt. Dept. of Public Works has awarded the breakwater contract to General Contractor, Wm. Bermingham. $130,082.

Oak Point, N.B.
The contract for dredging has been

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **January 21, 1914** **No. 3**

Principal Contents

"Robbing Peter" and Like Procedure ... 61
The City Manager Plan ... 61
"My Greatest Mistake" ... 61
Excessive Self-Confidence in Engineers ... 62
Part of the Electrical Industries in Canada's Future ... 63
Purchase of City Supplies ... 64
Letter to the Editor ... 65
"A Winnipeg Contracting Firm" on "Fair Play to Contractors Tendering for Public Works."
The Unaccepted Tender ... 66
Building the Substructure of the New C. P. R. Kildonan Bridge over the Red River ... 67
Decorative Possibilities of Concrete (Conclusion) ... 70
Movement of Tall Buildings ... 78
The New Weart Block, Vancouver ... 79
Organizing and Executing the Construction of a Reinforced Concrete Industrial Building (Conclusion) . 80
Erection Features of the Quebec Bridge ... 82
Wood Block and Asphalt Block Pavements ... 84
Economics of the Water Meter ... 85
Concrete Tile Blocks Manufactured by Wet Process... 86
Suggested Design for Reinforced Concrete Poles ... 86
Canada Cement Company's New Plant ... 87
McCallum, Hill & Company's New Building, Regina .. 87
Wind Load on Buildings ... 88
Loew Theatre Company's New Building, Toronto ... 89
Constructional News ... 90

"Robbing Peter" and Like Procedure

THE folly of such procedure in estimating as "robbing Peter to pay Paul" forms the subject of an interesting letter contributed to this issue by a prominent Winnipeg contracting concern. In the main the letter constitutes a plea for a higher standard of ethics—not only for the contractor, but also for the engineer and the owner. The basic principle established is that competitive tendering is a "competition" only to the extent of securing from contractors figures computed according to a common standard. It is opposed to all fairness, and it militates against the best interest of everybody concerned, to take competitive bidding at its lowest appraisal—as a scheme for luring contractors into submitting bids which entail either loss or a bare clearance.

We hear a great deal about scamped operations and inferior material in public works, but is not much of this due to a mistaken idea prevalent in some quarters that in dealing with contractors it is a good policy not to "do unto others. . . . . ," but to do others before they get a chance to do you?

Doubtless our correspondent's argument will appeal to those who are interested in the broad, constructive work of raising contracting standards.

The City Manager Plan

THE city of Dayton, Ohio, is entering upon an experiment the result of which, in regard to its relative efficiency, will provide many cities on both sides of the border with material for careful reflection. At Dayton an experienced civil engineer has just been appointed to the office of City Manager. As at Staunton, Va., and other cities, this official will have authority over all public works and will be held responsible for expenditures. He will defer to council only on matters of general municipal policy. In favor of the commission plan of government on these lines it is argued that it is possible to manage a city just as a private business is controlled by a board of directors and a general manager. Under a city manager of the type that has been appointed at Dayton the development of a city proceeds with due regard to engineering principles. Where a town is too small to have a regular city engineer the city manager plan has many advantages, but upon a revised and enlarged scale it would appear to apply to the large cities. A discussion of the scheme put into effect at Dayton, Ohio, would be timely following upon the editorial article, "Engineering Responsibilities and Lay Administration," published in our last issue.

"My Greatest Mistake"

OUR esteemed contemporary, Engineering and Contracting, publishes in all seriousness an editorial article under the heading, "Should Engineers Describe Their Failures as Well as Their Successes?" This recounts how two prominent engineers were discussing the subject-matter of the general run of articles in engineering papers and how it was agreed that it would be of great value to the profession if a series of letters could be published under the general caption, "My Greatest Mistake in Engineering Practice." Our contemporary, while doubting the practicability of such a scheme, commends it on a modified basis and states that it is incumbent upon a man who has published a description of one of his designs to make public later the nature of any considerable shortcoming revealed in that design after it has been placed in use.

To our mind this provides a rich and rare exemplification of what is all right in theory but poor in practice. Imagine the reminiscences of a score of our leading Canadian municipal engineers published in book form under such a heading as that suggested! In the first article City Engineer Brown would tell how he made a mess of the water supply at Hogtown, and in the second City Engineer Jones would narrate how he wasted thousands of dollars in under-estimating the requirements of the city's sewerage department. Records of failure written in a general way are well enough handed down from the last generation, but we live in an age when nothing counts like success. However much we might profit by the mistakes of others, to advertise our shortcomings as designers and constructors would be inviting the fate of the dog who after being given a bad name came to the ignominious end of hanging. There may be one or two outstanding geniuses in the engineering field whose records would survive any publicity given to their greatest mistakes, but it would spell FINIS to the professional career of the rank and file in the engineering community.

Excessive Self-Confidence in Engineers

EVERY virtue carried to extremes becomes a vice. Self-confidence, which is essential to all success, often degenerates into a pure egotism that presages failure. The training that the modern engineer receives is one that is rightly planned to give a feeling of self-assurance, but we fear that, at least in many instances, too great self-assurance exists among engineers. The evidences? Several, but two will suffice.

Consulting engineers are in comparatively slight demand for most kinds of engineering work. Take railways for example. Where are the Wellingtons—the consulting experts in the economics of railway location? Where are the consulting experts in railway operation? Scan the pages of "professional cards" in engineering periodicals and come to a better realization of the fact that there is virtually no demand for consulting engineers in railway location, construction and operation. Is it because every railway has already all the best experts available? One might easily think so if one were influenced by the evidence of lack of demand for consulting experts.

Turn now to highway engineering. Here we find a few—a very few—names of consulting engineers. Can it be that every city engineer and every county engineer is already a past master in the art and science of highway economics? One might infer as much from the general indifference to outside engineering advice, unless that advice is gratis.

Once there was quite a large array of names of consulting bridge engineers. Gradually the list has dwindled. Is this also due to universal knowledge of bridge economics? We fear that many an engineer has mistaken a knowledge of all structural economics, and has greatly underestimated the difficulty of designing the most economic bridge for a given condition. When we consider that hundreds of millions of dollars are annually spent in every large branch of engineering, and when we note how scarce are the names of consulting engineers even in those branches where advice is most commonly sought, we are startled by the evidences of hyper-confidence to be found on every side.

Self-confidence is not the only factor that operates to reduce the ranks of consulting engineers. Many employers have yet to learn that the profession of engineering differs from that of law and medicine One attorney or one doctor is all that the average man feels he can afford to handle his case. It is yet to be learned that more than one engineer can often be profitably employed to direct an engineering "case." But how is this fact to be learned by employers? Surely not by our keeping silence. Either self-confidence or timidity, then, is at the bottom of the general reluctance of engineers to ask for the advice of consulting engineers.

Another evidence of the existence of too much self-confidence is to be seen in the relatively slow and small sale of engineering books and in the scanty libraries of most engineers. Taking even the best engineering treatises—those commended highly by reviewers and purchasers—we find that the sales are much below the known number of those who could profit from the books. Go into the office of any lawyer and look at the shelf upon shelf of books. The four walls of his office are book filled. Then go to the office of an engineer. Eliot's "five-foot shelf" will ordinarily hold all the engineering books there and yet remain partly empty. Making due allowance for the difference between the practice of precedent and the practice of science, the meagerness of the average engineer's library is noteworthy. The lawyer, it is true, gains more and larger fees in proportion to his success and therefore has a strong incentive to leave no means unused to win. Hence the great store of precedents and statutes that he accumulates for his guidance. The engineer, it is true, commonly gains little more in salary because he saves money for his employer—an employer who, by the way, can seldom recognize engineering economy when he sees it. Yet is it not a mistaken policy that leads the engineer to curtail his expenditures for literature?

But even in those offices where the employer could easily be persuaded to buy all needed engineering books and to have files of bound periodicals we seldom see an adequate engineering library. How many railway companies, for example, have an engineering library worthy of the name? Is the absence of engineering treatises in the libraries of such companies an evidence of parsimony? If so, it speaks ill of the persuasive powers and the standing of the engineers in the employ of the companies. We think, rather: that the main reason is a deeper one. We believe that many engineers are prone to solve most of their problems with the aid of a "pocketbook" and a slide rule.

Where have we engineers acquired these habits of hyper-confidence? Largely, we think, in the school room. Starting as small boys, we have been trained to glean nearly all our knowledge on one subject from one book, and to use that one book for nearly all reference purposes. Unfortunately, too, that one book has rarely given a hint that it contains only a small fragment of the total published knowledge on its subject. Seldom does a text book introduce the two sides, to say nothing of the many sides, of a controversy—and what scientific subject other than mathematics is not open to debate? Then, also, the text books tend to exalt "principles" and to make light of the mass of "confusing facts." The habit of reasoning from established principles is rightly formed, but the equally important habit of consulting all the important data with which to reason is not formed at all at our schools, and seldom at our engineering colleges. Yet, of two men, the one a trained logician and scientific analyst, and the other poorly trained in formal reasoning, which would it be the safer to choose to solve an engineering problem, assuming the first man to be no digger for data and the second to be most thorough in his search for facts?

Most of the errors in reasoning are not due to improper ratiocination but to inadequate data.

This is true of all forms of reasoning. It is true in marked degree of reasoning on matters of economics and that includes en-gineering. As for inductive reasoning, it is self-evident that many data must be gathered before correct theories or generalizations can be formulated, but it is not always appreciated that for correct deductive reasoning—ratiocination—it is also imperative that many data be available. A correct formula is of little use if suitable constants be not used in its application.

When we part from that small area of engineering practice where formulas are applicable and enter that boundless tract where art is more in evidence than science, we should be even more impressed with the desirability of having at hand a wealth of examples and recorded results of experience. How pinched then looks the self-secured knowledge of any individual. How barren the best of text books written primarily to impart principles.

Teachers, as we have frequently remarked in the past, have acquired a habit of overlooking the importance of drilling correct habits into their pupils. It does not suffice to train a pupil in deductive reasoning and to give him practically no training in the all-important practice of research. The problems of everyday engineering bear little relation to a "final examination" where memory and reasoning power must alone serve.

Perhaps the worst indictment that a young engineer can have from an employer is one that pronounces him careless. This does not mean merely that his addition or multiplication fails to be correct. A graver and more common carelessness is that which may be called lack of thoroughness; and it is this form of carelessness that is apt to show most prominently in a man who has been drilled mainly in deductive reasoning. It were better that an engineer were trained to thoroughness in research at the expense of thoroughness of mathematics, than that the reverse be true. Yet the reverse is usually true.

Most of the celebrated consulting engineers are men of great thoroughness. Few stones are unturned by them when a new problem arises. They can reason no better than many of their assistants, but they can and do go farther in their search for facts with which to reason. They travel over many states and countries, searching for facts. They accumulate large libraries of their own, and they make constant use of still larger collections of engineering literature. Theirs is the function to be thorough, and in this thoroughness alone lies most of their success. Often berated for poverty of personal experience, they are rich in the experience of others which they have made their own. What a pale, small candle flame is the personal experience of any man when brought before the sun of the great experience of humanity? And this vast sun, what is it? An immensity composed of specks—a stupendous integral of infinitesimals. Facts are to the reasoner what the sun's rays are to the plant. No idea can grow in the absence of data. To display self-confidence where data are meagerly known is to give evidence of unbalanced training, yet many a recent graduate engineer is thus confident, nor are his elders entirely blameless in the same score.—Engineering & Contracting.

The Part of the Electrical Industries in Canada's Future

FUTURE Prospects formed part of the subject of an illuminating address delivered recently by Mr. Frederic Nicholls, President of the Canadian General Electric Company, Limited, at a meeting of directors held to commemorate the 25th anniversary of a syndicate whose extensive operations are now conducted under the firm name which is so frequently abbreviated into "The C. G. E." After giving the history of the company, Mr. Nicholls stated in part:

"I do not desire to pose as a prophet, for the reason that our own future must run parallel to the future development of our country. Personally, I have the utmost faith in the future development and continued prosperity of Canada. Occasional set-backs we must expect, but the march of progress must be always onward, as so much of our great country still remains to be developed and populated. Next year, two new transcontinental railways, the Canadian Northern and the Grand Trunk Pacific, will be in operation for the first time, operating through trains from the Atlantic to the Pacific. The Canadian Pacific Railway have increased their trackage, rolling stock, and other facilities, at an expenditure equal to that required to build a new railway from ocean to ocean. The contracts for the new Welland Ship Canal have been let by the Dominion Government. Public works of great magnitude are either under construction or being projected by the Federal and Provincial Governments. Up to the present our immigration has continued to increase, so that, taking it all in all, the future is full of promise, even though for some short while we may experience a recession in trade, as a result of the present world-wide financial uncertainty.

"Mr. F. A. Vanderlip, President of the National City Bank of New York, an authority on financial and trade statistics, in a recent address, made the statement that the intelligent development of the electrical industry in the United States will readily asorb for the next five years, $400,000,000 a year, or $8,000,000 a week.

"I do not predict that in Canada our percentage of trade, on a pro rata population basis, will be so startling, but there is no reason why we should not expect a satisfactory growth in the demand for our products.

"A normal growth of population may be counted on. The trunk line railways will undoubtedly electrify certain sections, such as terminals and mountainous divisions, and I am pleased to say that the first two important contracts that have been let for the electrification of steam railways in Canada have been awarded to this company. I refer to the electrification of the Rossland-Castlegar division of the Canadian Pacific Railway in the Rocky Mountains, and the electrification of the tunnel under Mount Royal, and the Montreal Terminal, for the Canadian Northern Railway.

"In considering the future uses of electricity in Canada, we must have in mind the impetus this industry has received as a result of the utilization of our magnificent water powers. Few realize that from Quebec in the East, to Victoria, British Columbia, in the West, nearly every city, town and village has the advantage of hydro-electric power for its lighting, its street railways, and its industries. Quebec, Montreal, Ottawa, Toronto, London, Port Arthur, Fort William, Winnipeg, Calgary, Vancouver, Victoria, and intermediate points, are all operating electrically, and our reserves of water powers undeveloped will serve the needs of the country beyond our time."

Clay-workers to meet Next Week in Toronto

THE Twelfth Annual Convention of the Canadian National Clay Products Association, formerly the Canadian Clay Products Manufacturers' Association, will be held at the King Edward Hotel from Tuesday to Friday, January 27-30. The president of the association is Mr. Chas. A. Millar, Toronto (a valued contributor to the Contract Record) and the secretary Mr. John R. Walsh, of Toronto. A number of interesting papers are scheduled for presentation at the meeting. The authors include several gentlemen well-known to readers of the Contract Record—Mr. Joseph Keele, of Toronto; Professor M. B. Baker, of Kingston, and Professor Day, of Guelph, for example. It is hoped to make the meeting as valuable as possible from the technical standpoint, and the papers and discussions will cover practically every phase of the industry and deal with everyday difficulties in operation. On Friday evening a unique entertainment will be given at Park Theatre, where, in addition to the regular vaudeville and picture show, there will be films showing brick plants, brick roads and other views of special interest to the trade. It is of interest to note that Park Theatre was erected by a former President of the Association, Mr. D. A. Lochrie, and that it is managed by a man named S. M. Brick.

Particulars as to membership in the Association and further details concerning the coming convention may be obtained on application to the Secretary, Mr. John R. Walsh, 40 Blake Street, Toronto.

A reinforced concrete crane-pontoon, 30 m. long by 13 m. wide, fitted with a motor and screw, and capable of being navigated by its own power, has been constructed at Marseilles. It is to carry a crane 10 m. high, with an overhanging or unsupported length of 10 m., able to support a load of 30 tons. The pontoon has double sides, protecting it against the influx of water should the outer skin be damaged.

Whilst excavations were being made for the drains for the new gymnasium in the course of erection in the grounds of the Simon Langton Schools, Canterbury, Eng., the workmen unearthed a good specimen of a Roman tessellated pavement. Unfortunately, before they realized the value of the find, the mosaic had been considerably damaged by the pick. Excavations on four previous occasions in the school grounds have reached, at a uniform depth of 7 ft. from the present surface level, similar portions of tessellated pavement, the last occasion being some seven years ago. The original buildings of the monastry of the White Friars were evidently built on the site of a Roman villa.

The Purchase of City Supplies

SOME valuable observations on the purchase of city supplies are made in a report by E. C. Church on the organization and administration of the Supply Bureau of the Department of Water Supply, New York. The system employed in this department is of such a high order that the operations of the Bureau are practically automatic. Mr. Church is Secretary of the Department and Chief of the Bureau of Supplies. The fundamentals which he lays down are based upon a most commendable combination of successful experience and common sense. Following is an abstract of his report:

All supplies ordered and bought should be really necessary and should be those best suited to the use to which they are to be put. It frequently happens that large sums are wasted by calling for materials far too expensive and of too high a grade for the purpose intended. Again, it sometimes happens that poor material is bought because it is cheap, whereas a better and more costly article would have rendered proportionately for more service. To obviate this, standards and written specifications are recommended so that the most suitable supplies may be bought and the same article used for the same purpose throughout the entire department.

The precise quantity needed should be ordered. When a man leads a hand-to-mouth existence, continually ordering small quantities of material, he puts the purchasing division to a lot of expense, as it costs nearly twice as much to handle a small order as a large one. The cost of delivery is away out of proportion to the size of the shipment and the necessity for inspecting each lot increases inspection costs. On the other hand, when told to do a piece of work most men "get on the safe side" and order far more material than close figuring would show to be necessary. This is particularly true where the machinery of purchasing is cumbersome. A man hates the bother of making out another order for additional stock. If more material has to be purchased and there is much red tape he may have to wait a long time and the job will be delayed. Quantities should be checked and men held responsible for extravagant requisitions. Interest on investment, depreciation and other losses must be reckoned with.

Purchases should be made in accordance with a definite plan and under most favorable market conditions. It frequently happens that a half dozen requisitions to purchase some standard material are sent in one at a time during the course of the year as the various projects develop on which the material is wanted. Ordering supplies in this manner is unsatisfactory. It greatly increases the office expense for purchasing, it prevents the combination of similar requisitions in order to obtain wholesale prices, and the fact that immediate delivery is generally demanded makes it impossible to wait for favorable markets before buying.

One improvement is that a large proportion of the supplies now bought are ordered in advance and instead of being delivered direct to the consumer are consigned to the nearest storehouse, where they are inspected and stored and later delivered from stock as called for on requisition. In this case the stores act as distributing depots.

Fixing Limits of Stock

The amount of money invested in material should be kept at a minimum. Fixing the limits of stock to be carried is most important. In order to know the proper amount of stock to keep on hand, the chief of the bureau of supplies should be in close touch with the work of the department as a whole, and with the details of that "program," before referred to, which is supposed to regulate all activities. He should know of all new work and all contemplated improvements a sufficient time in advance to purchase the required supplies in a favorable market, and to have them delivered, inspected and ready when needed. He should be informed concerning the amount and nature of materials necessary to be kept in reserve at certain points for various emergencies. He should be fully posted regarding the stores required for current operating purposes, and any changes in "policy" which will affect the same. Using these facts in connection with the data on the time required to obtain or replenish stock by purchase or transfer makes it easy to calculate the minimum quantities of stock to be kept in storage.

The question of the proper amounts of emergency equipment, spare parts, tools, implements and current supplies to be maintained by the operating divisions is most important, though apparently it has not yet been standardized.

Materials should be properly stored and issued. It has always been considered a grave error in organization to place the control of materials and supplies, in large quantities, in the hands of the men who use them. The bureau has insisted that it should store all materials and supplies prior to issue. under the care of responsible men especially detailed to that work. With this end in view, it has always assumed charge of storage points whenever permitted to do so. The economy in consumption and diminution of waste effected by this control has been remarkable. The previous improper methods of storage and accounting for supplies have become apparent as the various storage points have been placed under the jurisdiction of the bureau. Rules for the care and storage of supplies after issue from stores and while in the hands of the ultimate consumers should be prepared and enforced.

Supplies should be put only to the use intended. This is a matter only partially within the control of the bureau. Purchasing agents can assure themselves that goods bought are suitable for the requirements, and storekeepers can report when goods requisitioned out of stores are not suited to the ostensible use to which they are to be put, as stated on the order. They can also prevent deterioration in stock and loss from theft, which certainly do not come under the head of "use intended."

Supplies should be used efficiently and economically. No matter how careful and saving the bureau may be in the matter of purchase, inspection, storage and issue of supplies, if the men using the material use it inefficiently or wastefully it will soon give out and have to be replaced.

Supplies should be kept in service till they are worn out or changed conditions require the substitution of a more efficient or more economical article. Loss is often incurred by premature replacement of materials. To the cost of the new article must be added the cost of the replacement plus the remaining value of the article replaced, which can seldom be used elsewhere.

Unnecessary Restrictions

All useless, burdensome and foolish restrictions and conditions should be removed from the bidding requirements and the specifications. The city's business should be made as attractive to possible bidders as is that of any of the great private corporations. On the contrary, doing business with the city is now fraught with many needless annoyances and restrictions. Many of the conditions so imposed cause the contractor actual expense, while others merely introduce elements of uncertainty and possible loss against which he must protect himself by increasing his bid proportionately. All such restrictions, whether actual or potential, are ever present handicaps to proper economy.

Some of the conditions are imposed by law; others are the result of bad purchasing methods, improperly worded specifications, inefficient office procedure or conduct of employees. It is foolish to imagine that the lowest possible prices have been obtained merely because the letting was public, bids being taken, and the award made to the lowest bidder; for many may not have bid who otherwise would have been glad to put in a price, and others who did bid might have bid lower.

The disposition to be made of excess stores or equipment and obsolete or damaged material constitutes the one remaining point where the activities of the Bureau of Supplies are so closely related to those of other branches of the department that friction has often resulted. This work can best be done by a board of survey, consisting of an official of the bureau and a "staff" engineer. They should periodically inspect and survey all stores, equipment, engine spare parts or other supplies owned by the department for the purpose of (1) condemning and ordering to be sold all (a) obsolete material and (b) damaged material not fit to be repaired and (2) ascertaining whether such material as may be damaged or worn is worth repairing, and, if worth repairing, directing that said work be done.

LETTERS

Fair Play to Contractors Tendering for Public Works

Winnipeg, Jan. 7, 1914.

Editor Contract Record:

We have been greatly interested in your articles, "The Gratuitous Bid" and "Competitive Tendering," and by the ensuing discussion. While we are too busy at the time to enter into any controversy, we appreciate your efforts to mitigate contracting handicaps, and to translate our appreciation into practical form we have pleasure in sending you a few observations.

It is frequently the custom to give the contractor a set of plans and specifications without estimate, to be paid for at the lump sum price bid, with provision that if the quantities in any part of the work are more or less than are shown by the plans, additions or deductions shall be made at prices either fixed arbitrarily by the engineer or "to be mutually agreed on"—which means practically the same thing as the engineer's arbitrarily fixing the allowance. The contractor is not given the benefit of the engineer's estimate of quantities and if he happens to erroneously calculate the quantities from the plans, the loss is his. If he over-estimates the quantities on which his lump sum bid is based, he loses, because his bid is higher than his competitor's, even though he may have figured on a lower unit basis of cost and profit than his successful competitor. If he estimates too low, then the loss is his in a place that hurts, that is, furnishing without charge labor and materials on which he did not estimate. Could anything contribute more toward—or more forcibly invite—collusion between contractors, merely as a matter of "self-preservation?" When comparing notes as to quantities, what is more natural than that the contractors should try to agree on prices and endeavour between themselves to parcel out the contract before the bids are open?

The engineer who makes the plans is in the best position to estimate the quantities accurately. Why not give these most correct estimates of quantities to all bidders and take bids at unit prices—say, for instance, on paving work per cubic yard of excavation; per cubic yard of base; per square yard of pavement surface; per lineal foot of curb, etc.,—and canvass the tenders and pay for the work on the basis of the unit prices and the actual quantities of work of each class actually performed?

In the New York State Highway Department work it is the custom to take bids on "grubbing and clearing" at a lump sum for the entire contract. Until recently any bid which exceeded the engineer's estimate by more than ten per cent. in any item was regarded as informal, and rejected. If on the item of "grubbing and clearing" for instance, the engineer did not know that any would be required, he followed, and still follows, the custom of estimating the nominal lump sum of one dollar and the contractor might tender as high as one dollar and ten cents, and have his bid considered. If the contractor in going over the work happened to see that the engineer's estimate was erroneous, whether by carelessness or design, and that the work would probably necessitate the removal of a lot of trees, stumps, road-side underbrush, or other of the variety of work classed as "grubbing and clearing," and he estimated that the cost would be, say $1,000, he must either "absorb" the loss and "trust to his wits" to get it back out of the contract in some way, or he must "unbalance his bid" by distributing the amount among other items of his tender with the almost certainty that other less careful contractors will "take the engineer at his word" and assume that no "grubbing and clearing" will be required, and the careful conservative contractor would thus stand that $1,000 chance of not being the low bidder. There are cases where on two miles of work the line stakes finally given by the engineer conflicted with large trees and other obstructions which had to be removed at a cost of over $1,000, the contractor in tendering for the work having erroneously assumed that the "engineer knew his business" when he estimated, "grubbing and clearing, lump sum one dollar." In such a case is not the contractor almost justified if he tries to save that $1,000 in cement or some other item by "stealing it from the contract?" Why is it more than common honesty, if the engineer does not see that any "grubbing and clearing" is to be done, to make no estimate and take no bid on that item, and, if unforeseen work is found, "pay for the work actually performed as an extra item at cost plus 15 per cent.," or at "prices to be agreed on?" If any "grubbing and clearing" is anticipated by the engineer, why not take bids therefore at unit prices, say, "per acre removing brushwood and debris;" "per tree or stump," with separate prices for trees or stumps having diameters of say 6-in., 12-in., 18-in. and 24-in?

It is believed that in some cases the engineer is so narrow as to purposely undertake to "put one over" the contractor through such means as we have outlined above, which are only samples of the many ways in which contractors are treated unjustly.

Adequate and Uniform Information

The sooner the engineer provides unit items and prices and accurately estimates quantities for every item, the sooner there will be removed one of the most potent factors in encouraging, yea forcing, dishonesty on the part of the contractor, and the sooner the cause for suspicion of contractors in general will be removed and the "owner" or "employer" will get honest workmanship at fair prices, which is the end to which the owner, as well as the contractor, should be working. The owner should be just as keen to see that the contractor's bid is not too low as to see that it is not too high, and if the contractor, through oversight or error, tender too low, not only should he not be penalized for refusing the contract, but it is to the interest of the owner that his bid should be rejected, for it is axiomatic that when the contractor is not getting a fair price for his work, the owner is not getting value or satisfaction.

With a contract which is fair and square to both the parties at prices allowing the contractor a reasonable profit, the basis of mutual fair dealing is established and unless one party or the other be more dishonest than most men mean to be, the result will be satisfactory to all concerned. The contractor will have completed a construction which is satisfactory to the owner and a monument to himself, and he will have accomplished what every man is entitled to, namely, a fair return for a fair outlay.

Yours very truly,
"A Winnipeg Contracting Firm."

The Unaccepted Tender

Our London contemporary, The Surveyor, contributes the following, editorially, to the discussion inaugurated recently in these columns:

"Under the title "The Gratuitous Bid" there appeared lately in the Contract Record an article in which the writer advocates the payment of contractors for the time and labour which they expend upon the preparation of their tenders. The argument is based upon the hypothesis that philanthropy has no place in commerce, and that payment or promise of payment is the basic condition in every business transaction. We are bound to say that the whole thesis appears to us to be founded upon a misapprehension. In the first place, the submission of a tender is a purely voluntary act on the part of each individual contractor, and in the second place the submission of a tender is merely an offer on the part of a contractor to do the work at the price quoted, such offers having been invited by the advertisement of the contract. Why should a public authority or private individual pay a contractor for his trouble in making an offer If such payment is to be made, what safeguard is there to be against the making of offers which are not bona-fide meant to be accepted? These are some of the questions which must be answered before a case is made out for the suggested innovation.. It is clear that in law none of the tenders or offers received need be accepted, even if the usual stipulation that "the lowest or any tender will not necessarily be accepted" is absent. Further, a tender may be withdrawn at any time before acceptance. These are matters grounded upon the first principles of the law of contract, with which contractors ought to be thoroughly familiar. The preparation of offers to do work is, in our view, an ordinary business expense which every contractor knows he must incur, and which ought to be paid out of the margin of profit which he makes upon the works which he carries out."

A paper on the Manistee River viaduct, presented to the Western Society of Engineers by Mr. W. T. Curtis, describes some unusual work in pile driving and pier construction for the foundation of additional supports for the viaduct. Nearly 400 piles were driven to a penetration of 35 ft. in clusters of six and twelve on both sides of and close to the bents of the existing viaduct towers. All of the piles were driven through an old corduroy road which was discovered several feet below the surface of the ground and caused much difficulty and expense in removing or cutting through the logs. The pile driver had to be moved several times for each cluster of piles and was handled very advantageously from the deck of the bridge 75 ft. above the surface of the ground. The pile-driver tower, suspended from its center of gravity, was turned bottom side up and lowered between the tower bracing to the required position, where it was braced or guyed and a hammer operated between its leads to drive the piles as required. The engine was moved separately from the driver and the work was carried on without removing any of the old tower bracing. Sand and gravel for the concrete piers were dumped through the track above to stock piles formed on grillages of old ties set on the surface of the ice 75 feet below. The materials were distributed over the ice, mixed at the forms and deposited under water in very cold weather.

View of west approach and bridge.

Building the Substructure of the New C. P. R. Kildonan Bridge over the Red River

THE freight cut-off line of the Canadian Pacific Railway from Bergen, Man., to the large new terminal yards at North Transcona, crosses the Red River about two miles north of Winnipeg, a few hundred yards south of the old Kildonan Church and ferry. The new bridge is to have seven concrete piers and two abutments, with half-deck plate girder approaches to three truss spans on the river. From face to face of the abutment ballast walls the lengths will be approximately 930 ft.

The substructure work, which was done in the winter of 1912 and the spring and summer of 1913 by The Foundation Company, Limited, was of rather a difficult nature owing to the soft river bottom. Active work was started on December 17th, 1912, taking advantage of the ice, although a small force had been occupied for a number of weeks prior to this in building camp and fitting up the large plant necessary for the job. In addition to this a pile trestle was built over a ravine east of the bridge site to enable a spur to be laid down to the river bank for unloading materials and plant.

Night work was started on December 30th and the double shift maintained until April 7th, when the rising waters of the river and consequent breaking up of the ice necessitated a considerable reduction in the force of men and caused work on the river to be temporarily delayed. During the high water period operations were continued, however, on both banks of the river, a day shift only being used. Night work was again resumed on July 7th in connection with the pneumatic caissons and final concrete work and was continued until the work was finished on August 30th.

It had been expected to have three river piers completed during the winter by working on the ice, but owing to its breaking up earlier than usual, only two were brought above summer water level. The third pier had been safely bottomed and the shaft started when high water necessitated stopping work temporarily on sand. By means of a heavy timber crib, carried to above summer water level, which had been built before the breaking up of the ice, operations were resumed by pumping down after the flood had subsided.

Pier Design

The original design of the bridge called for two abutments and six piers resting on wooden pile foundations and three mid-river piers with footings carried to rock. During the course of the work this design was changed considerably to suit conditions as they arose, so that the bridge as built is as follows: two abutments and four piers on piles, the pivot pier and

Piers, east abutment and west trestle.

west resting pier, sunk by the pneumatic caisson method, and east resting pier, resting on four concrete shafts extending to rock. Thus two piers were omitted entirely, the second pier out from the original planned west abutment becoming the west abutment.

A rather unique feature in bridge design occurred in connection with the west abutment. From past experience with the soft Red River Valley soil, it was decided to guard against posible sliding of the end of the fill approach. Accordingly, a wedge-shaped cellular anchor was built on the fill side of the abutment, consisting of 2-ft. concrete walls enclosing hollow pockets (these pockets to be train-filled later with gravel). These pocket walls rested on a concrete slab, two feet thick, covering the whole anchor site, and this, in turn, rested on piles.

As an additional safeguard against the slipping of the embankment, four rows of six piles each were driven west of this anchor and cut off five feet above the ground.

Heavy Plant.—This consisted of the following for the open work part of the contract: 5 double-drum hoisting engines; 1 three-drum hoisting engine; 6 stiff leg derricks; one 100 h.p. oil city boiler; two 80 h.p. Kewannee boilers; 2 drop hammers; 1 Vulcan steam pile hammer; 1 New Monarch steam pile hammer; one 1-yd. Marsh-Capron mixer; one 1-yd. Ransome mixer; two 8-in. centrifugal pumps; one No. 4, two No. 3 and two No. 2 Nye steam pumps, besides smaller pumps and buckets. Assistance was had from a ¾-yd. Smith mixer and a ¾-yd. Chicago mixer hired for a short time during the spring.

For the compressed air portion of the work in July and August the following plant units were used in conjunction with the above list: one 90 h.p. Ames boiler; one 24-in. x 24-in. x 30-in. Ingersoll-Sargeant Air Compressors; two 12-in. x 12-in. x 18-in. Canadian-Rand Class "C" Air Compressors; 2 air locks; 1 hospital lock, buckets, etc.

The principal item of interest in connection with this plant, aside from the quantity, is the bad quality of Red River water for boiler purposes.

Concrete Materials, Storage, Etc.—These were as follows: Canada brand cement, gravel from the Bird's Hill and Marquette Main Line pits, and crushed stone from the Manitoba Quarries, Limited. These were brought in and unloaded during the winter on the east side and during the summer on the west bank. A roadway was constructed down the east bank on to the ice and a large amount of the material required at the piers was teamed out to the different sites.

No cement was used until it had been tested and passed by the C. P. R. chemist in Winnipeg, where the gravel and stone were carefully inspected by the resident C. P. R. engineering staff.

Concrete Mixing and Placing.—The standard concrete mixture for this job consisted of one part cement, three parts sand and five parts stone.

The east abutment and three piers served directly from the east bank were concreted in two stages—before and after the spring flood. The "pre-flood" plant consisted of a ¾-yd. Smith mixer and 1-yd. Marsh-Capron mixer. In this manner the east abutment was carried up to the ground level; piers 9 and 8 to a safe distance above summer water level. During this winter season the concrete went directly from the mixer to the east abutment and pier 9 in derrick-handled buckets, but for piers 8 and 7 the concrete buckets were hauled over the ice on sleighs and the concrete was deposited by derricks commanding the piers. The second stage of the concreting at this east end of the bridge was handled by means of a pile trestle out as far as pier 7, concrete being deposited partially by derrick and partially by concrete buggies. Material was fed to the mixer from the storage pile by 1-yd. side dump cars hauled by horses.

General view of substructure work for Kildonan bridge, looking west from east bank.

On the west side the only pier started before the spring flood was pier 3. This was concreted up above the summer water level by the same ¾-yd. Smith mixer formerly used on the east bank. The west abutment and pier 3 were finished in the spring (soon after the flood had subsided) by the same derrick. For the top stages of pier 3, however, an elevated distributing tower was used.

The gravel and sand for the west bank mixing plant in this first stage of the concreting were hauled from the storage yard to the mixer in tilting dump cars, by means of long cables attached to an engine placed close to the mixer. The second and final stage of the concreting, embracing piers 4, 5 and 6, was vigorously prosecuted to a successful conclusion during the months of July and August. The battery of mixers for turning out this concrete was composed of the 1-yd. Ransome mixer and 1-yd. Marsh-Capron mixer, which were set up at the end of a long trestle leading out to the centre of the river. The concrete was hauled to within reach of the derricks at the different piers in buckets on flat cars along a narrow gauge railway.

These cars were fastened to a continuous cableway which was controlled by a standard hoisting engine placed close to the mixer. The concrete materials were delivered to the mixers in side-tilting dump cars from the adjacent storage yard. By this arrangement 200 yards of concreting was considered a fair 10 hours run.

Concrete Reinforcement.—For reinforcing purposes in all piers 50-lb. rails were used. Rails were also placed at the nose and shoulders of all river piers. These were locked securely into the concrete.

Sheeting—Wooden and Steel.—On the east and west abutments and pier 3, three-inch tongued and grooved sheeting was used, while at pier 9 this was increased to 4-in. At pier 8, where the water was deeper, 9-in. Wakefield, composed of three 3 x 12-in. boards, was found to give good results. The lengths of the latter sheeting varied from 30 to 36 ft.

At piers 7 and 4, forty-feet steel sheeting was driven. No trouble was experienced in doing this as no large boulders or other difficult material was encountered. To insure tightness at the time of pumping out, an outer row of steel sheeting was driven and the intervening space filled with clay. All of the above sheeting, both wooden and steel, was driven with steam hammers hung in suspended leads.

Open Excavation.—All piers and abutments—excepting piers 5 and 6, where the pneumatic caisson method was employed—were excavated in the open after pumping out the cofferdams. The material was removed in 1-yd. buckets by stiff leg derricks, two of these usually being set up at each pier.

During the winter season the heavy frost, which penetrated about six feet into the ground, naturally caused much inconvenience, but the continuous work of the day and night shifts helped matters considerably. At the sites of the river piers, the ice, about three feet thick, was removed from inside the cofferdam by steam under tarpaulins.

Pumps and Pumping.—Eight-inch centrifugal pumps were used for heavy duty, such as pumping a cofferdam from the river level down to river bottom, while suspended pumps, such as the Nye and Pulsometer, were used to handle any water leaking from the cofferdam. The principal difficulty experienced in this connection was during the winter season, when the severe cold weather caused considerable trouble, notwithstanding that the steam lines were heavily covered.

Pneumatic Caissons.—The two pneumatic caissons for the mid-river piers were built on the west bank and successfully launched and towed to place. The pivot pier caisson was approximately 65 x 35 ft. and the west rest pier 70 x 20 ft. British Columbia fir was used exclusively. The former caisson when launched weighed 110 tons and the latter 83 tons. On account of the large amount of timber in these caissons (178,000 ft. in the former and 142,000 ft. in the latter) considerable economy was effected in using pneumatic boring tools in drilling driftbolt holes, etc.

Caisson Sinking.—This part of the work was carried on very rapidly and smoothly, resulting in both piers being carried down to a satisfactory bottom in hard pan. The material encountered consisted of soft blue clay and black sand. As two air locks were used on each caisson and each was served by its own derrick, considerable excavation was made on each of the three eight-hour shifts. Where possible, and the nature of the soil would permit, blowpipes were used. The topping out of the shafts themselves at piers 5 and 6 completed the concrete work. This was finished on August 30, one day ahead of scheduled time.

The Foundation Company, Limited, of Montreal and Vancouver, were the contractors for the substructure, the work being carried on under the supervision of Mr. J. G. Sullivan, Chief Engineer of the C. P. R., and Mr. Frank Lee, Principal Assistant Engineer. Mr. W. F. Oldham was Resident Engineer.

Red Water in Municipal Supplies

The cause of "Red Water," suspended iron oxide in municipal supplies, has been studied by Mr. A. T. Stuart at the chemical laboratory of the Department of Agriculture Experimental Farm, Ottawa, Ont. Coils of iron wire and of iron-copper, iron-aluminum, and lead-aluminum combinations were suspended in bottles containing 400 c.c. of various waters to be examined. The tests were not carried beyond seven days, as it was felt that actual conditions in any city supply were then exaggerated. Raw and mechanically filtered waters from Watertown, N.Y., were used, together with raw, mechanically filtered, chlorinated, and magnesium-oxide precipitant samples from Ottawa. It was found that no appreciable difference existed in the action of raw or treated waters, so far as they could be revealed by losses in weight of the metals. There were, however, extreme and important differences in the character of the water. It was found that the raw waters, although corroding iron to the same extent as the others, did not coat the iron with as much flocculent material, nor did they allow the iron held to settle out, as is the case with treated waters, but retained a large proportion in solution or colloidal suspension. The treated waters, at ordinary temperatures, became very murky and opaque, and when hot, large amounts of brownish-red rust appeared ("red water"). From these it would appear that the state assumed by the iron taken from the immersed metal is a much more important question than the actual amount, and the inference is that the so-called mechanical filtration of these waters is liable to bring about this trouble. The waters examined were of low mineral content and highly colored by peaty substances.

Aqueduct signboards of the form of vitreous tiles are being placed on the inside surface of New York's Catskill aqueduct at every fifth station as a location guide for those making a boat or walking inspection within the conduit after its completion. Since the aqueduct is about 100 miles long, it would be difficult to determine one's location within the dark bore without these marking plates. The tiles will be placed on the left side of the aqueduct with respect to the direction of increasing stations, the logitudinal axis of each being about 3½ ft. above the invert of circular tunnels and 12 ft. above the invert of grade tunnels and cut-and-cover aqueduct. Each tile is 4 x 9 x ½ in., with two ⅜-in. holes for bolting to the aqueduct by bronze expansion bolts. Seventeen hundred tiles were inspected, 18 per cent. being rejected on account of cracks and insufficient glazing. Of those accepted, 21.5 per cent. were returned to the kiln for additional burning to meet the specified requirements in density. Three and one-half per cent. of the total were subjected to the red-ink test, which consists in immersing for one hour. At the end of this period the penetration should not exceed ⅛ in. in order to fulfil the requirements.

The Decorative Possibilities of Concrete

(Concluded from last issue)

NOTWITHSTANDING the excellent decorative work which has been done in plain and reinforced concrete, there are, nevertheless, numerous advocates of tile decoration. Instances are many where the use of brick or tile emphasizes the contour and enlivens the surface at very little expense. A little touch of color relieves the monotony of a single toned exterior and is illustrated in the seed warehouse of Otto Schwill & Company, at Memphis, Tenn. This building would undoubtedly be equally as efficient were it built without any attention to pleasing architectural effects. With the present leaning toward pleasant work rooms for employees, this idea has spread to the exterior with the result that our factories are surrounded by grass plots and gardens and the buildings themselves as far as possible are made to conform with the tendency toward providing pleasant environment.

The office building of the Packard Automobile Company at Buffalo, New York (Fig. 30), is an equally good example of the combination of concrete and brick, although the decoration is of cast concrete. Carrying this idea further, the Ford Automobile Company at Detroit, has not only built of reinforced concrete with brick inlay and corner towers but has called in mosaic tile to brighten up the panels under the cornice, and though the embellishment was achieved at some expense, the architect felt that the attention to this detail was deserved.

Another example of the use of colored clay tile for concrete decoration is to be found in Minneapolis, where on the north shore of Lake Calhoun a large building has been constructed of reinforced concrete, called the Calhoun Baths (Fig. 31). The central portion of the building is roofed and serves as the entrance, housing the ticket office, the rooms where bathing suits, towels, and keys to lockers are distributed, and the refectory. It also connects directly with the terrace above the bathing beach. The dressing rooms on the opposite side of the central portion of the building are without roof but are fitted with concrete rooms and steel lockers in double tiers. In order to reach the beach, the bathers must pass through a pool of water and through a triple shower direct from above and from both sides, so that a partial wetting is received before reaching the beach.

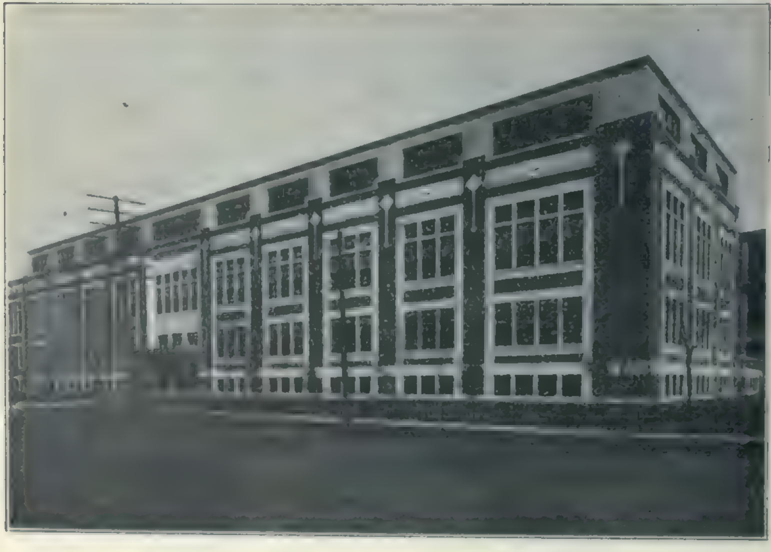


Fig. 30—Office building, Packard Automobile Company, Buffalo, N.Y.

The concrete was deposited rather dry in order to obtain a rough finish, and the form marks do not seem to detract in any way from the pleasing surface made by the coarse aggregate. The decorations are of brick and clay tile, the brick having been placed when the concrete was poured, but the tile subsequently, space being made of them by tacking wooden shapes to the inside of the form. The design and construction for this building were handled by Chapman & Magney of Minneapolis.

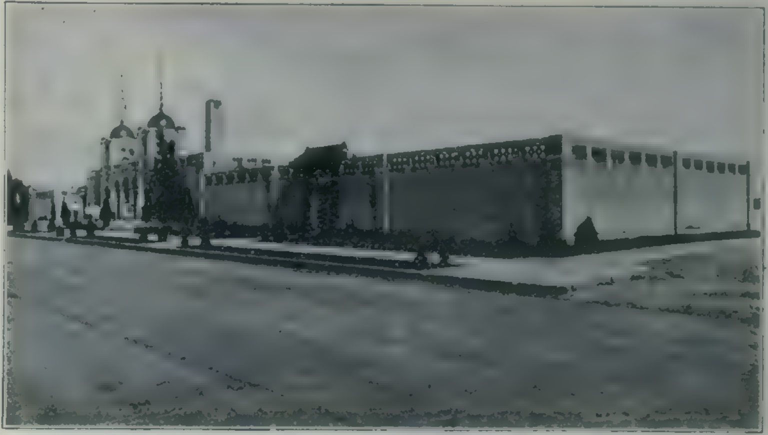


Fig. 31—General view of Calhoun Baths, Minn.

It is not surprising that an individual directly connected with the cement industry as is Albert Moyer, should build of concrete, nor is it surprising that one who is so well versed in concrete construction should obtain very pleasing effects as indicated by the work on his residence at South Orange, New Jersey (Fig. 32). Liberal use has been made of exposed aggregates, employing a mixture of Portland cement with limestone screenings, marble chips, and dark trap rock. Not stopping here, much dependence has been placed upon Moravian pottery decoration, which harmonizes well with the concrete surface, as is shown in the fireplace, with its inlaid panel showing an Indian at a fire, whether warming his hands or starting the blaze being not self-evident (Fig. 33). The balcony, also, has been worked out in pottery but somewhat differently than the fireplace. The distinguishing feature lies in the fact that instead of being inlaid, the figure comes out in base-relief and although somewhat serpentine in design, seems fairly consistent with the grape-vine motive. Undoubtedly this panel would be somewhat softened to its improvement by the ivy which was evidently not in leaf when the picture was

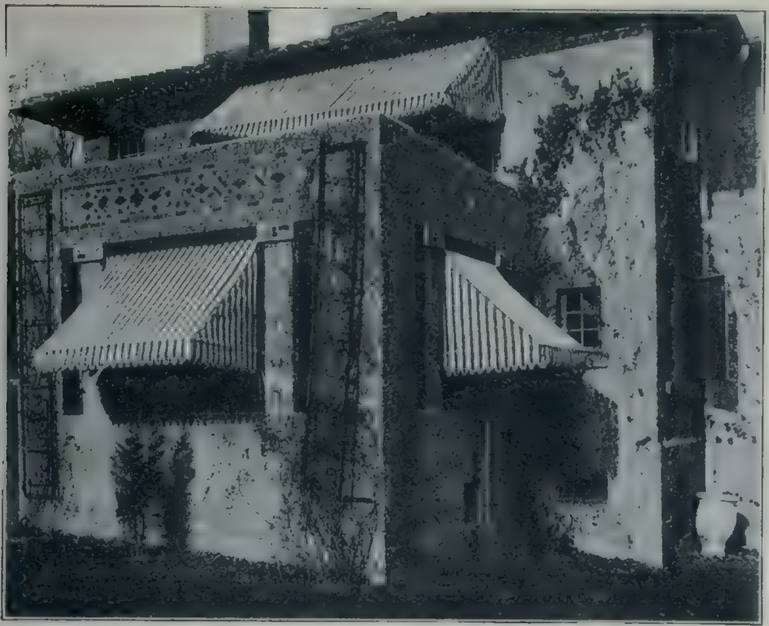


Fig. 32—Porch detail, residence of Albert Moyer, South Orange, N. J.

taken. For some time, Alfred Hopkins, of New York, has been a strong advocate of reinforced concrete for the construction of buildings and has added a large amount of information to our knowledge of the concrete of the old Romans, having investigated this point personally and in some detail. Nevertheless, Mr. Hopkins has never brought himself to believe that concrete should be used for the ornamentation upon buildings of the same material. For this purpose he advocates terra cotta, and judging from the excellent work which he has achieved on the residence of Charles E. Rushmore, there is reason in his contention. This building is all of reinforced concrete to the roof and part of this has been constructed of concrete slabs. But for the panels and column capitals, Mr. Hopkins has turned to terra cotta tile, with excellent results. For the average individual, of course, a detail of this kind would be prohibitive in cost. But with such a sized undertaking as this mammoth residence, the high individual cost of these panels (Fig. 34) is small when compared with the total cost of the building. However, with the advances which are being made in the use of colored aggregates, it is generally possible to obtain all the color variations necessary in the concrete itself.

It is not customary to build reinforced concrete roofs of the pitch type. In fact, there is no sensible reason for adhering to this construction when designing reinforced concrete (Fig. 35). The ideal concrete house is built with a flat roof not only because architecturally the design may be made pleasing, but because this type is the most economical in cost of space. An attic it of little use except for the storage of material which, in the majority of instances, will never be needed again, and when stored away in an attic corner, invites spontaneous combustion. Reinforced concrete has brought with it a new architecture and the sooner we appreciate its value, the earlier will be the general adoption of reinforced concrete for residences as well as the endless other types of construction to which it has already been applied.

Within the last few years, there has been a decided leaning toward the community settlement idea, and with this in view, the Forest Hills Gardens were designed (Fig. 36), not, as many people have inferred, an endowed neighborhood where buildings have been erected to house working people, but a business investment of the Russell Sage Foundation Company. It is in no sense managed as a charity, for whoever deals with it is expected to pay fair value for everything received. It is, however, an attempt to solve the housing problem for persons of modest means and its development will consequently be watched with interest. Perhaps this is the first example in America, where an absolutely barren site has been taken and treated along the lines of modern methods of town planning. Throughout the village, advantage has been taken of practically every structural material for building the dwellings, but a large part of the improvements has been worked out in concrete, including the railroad station, the city market, and many of the individual dwellings as well as garden walls, foundations and the like.

Oswald Hering has utilized lattice work on one of his most important dwellings in combination with decoration of molded concrete. But where Mr. Hopkins would use terra cotta, as in the panel inserts, Mr. Hering has used concrete, depending upon exposed aggregate to furnish the touch of color needed. Within, the lattice idea has been continued, but in an entirely novel manner by simply stenciling the lines upon the wall, instead of using wood as in the exterior panels (Fig. 37). Such lattice work would not find great favor with the particular housewife because of the tedious work of dusting.

Wood paneling will also break up large areas of concrete surface and is entirely in keeping with the old half-timbered style of architecture, so familiar to

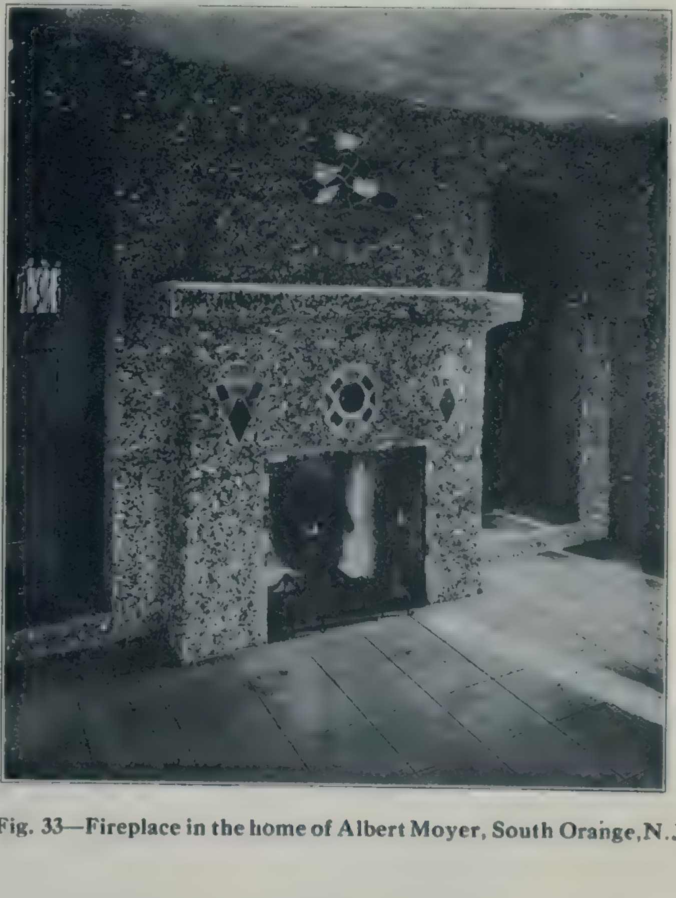


Fig. 33—Fireplace in the home of Albert Moyer, South Orange, N.J.

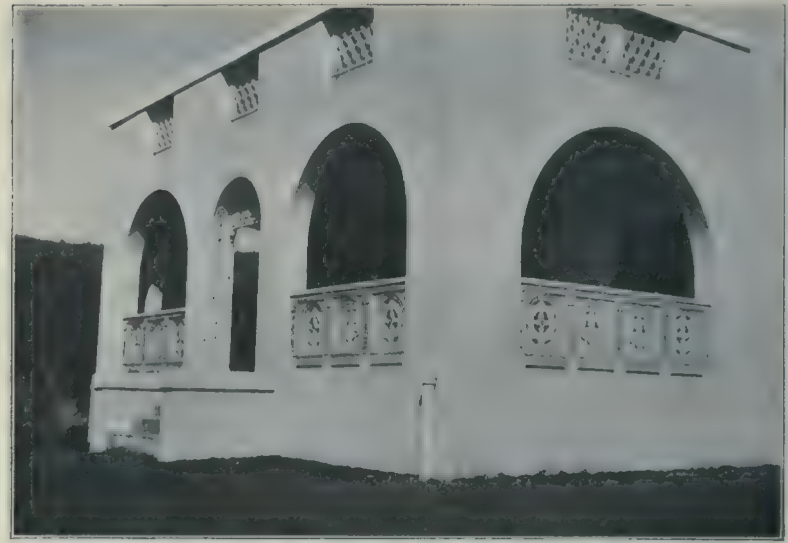


Fig. 34—Porch Detail, residence of Chas. E. Rushmore, Woodbury Falls, N. J.

our forefathers. It is impossible to appreciate the pleasing surface which has been obtained on this modest appearing dwelling (Fig. 38), but a slight explanation may help to make clear how the effect is obtained. The finish is known as a dry dash and in this instance has been applied to concrete blocks. After the plaster coat has been placed, a dash mixture of white marble and blue stone chips with gravel screenings is thrown on, which imbed in the mortar and furnish a clean, bright surface without further treatment. When a coarser effect is desired it can be obtained by a rough cast, the mortar mixture being thrown on with a paddle and the texture of the surface depending entirely upon the size and character of the aggregate and the consistency of the mixture.

Stucco finish has found favor when applied to concrete blocks as a backing, and there are some architects who believe that this is the only satisfactory means of handling what has seemed to be in many cases a sad makeshift so far as a building material having architectural merit is concerned. This impression has probably grown from the continued manufacture of rock-faced and inferior blocks by those who are entirely unqualified to undertake this kind of work. Such examples as the Normal Park Methodist Church in Chicago (Fig. 39), the blocks for which were built by the American Hydraulic Stone Company, and the design executed by H. B. Wheelock, has done much to eliminate this impression. The tone contrast was here obtained entirely by the use of colored aggregates, using the natural sand finish on the trim but a dark granite for the body. The surfaces were then scrubbed to expose the aggregate and the building is itself a strong recommendation for the much maligned concrete block.

Fig. 35—Cement stucco residence of L. G. Stumer, Chicago.

The residence of E. S. Harkness, at New London, Conn. (Fig. 40), is also of the same kind of blocks and depends for its merit not only upon a design appreciative of the value of the material but also upon the care in laying up the walls. Concrete blocks are not confined to exterior use, by any means, however, as is illustrated by the work of Emerson & Norris, on the interior of the Second National Bank Building in Boston. A combination of a tooled surface with careful laying and a little introduction of cast stone work has made the interior of this structure not only dignified, but thoroughly cool and resposeful.

Oswald Hering says that the so-called dry process concrete block is not of concrete at all. Having had little acquaintance with water during its process of manufacture, it consequently harbors an unquenchable thirst and when used in the outside walls of a building, proceeds to make up for lost time, every rain-storm furnishing the elements of a "spree" to the detriment of the block and the appearance of the dwelling. The dry process, however, is not necessary, it being equally as easy to add enough water to insure excellent concrete. The possibility of careful inspection during its manufacture is a strong point in favor of the continued use of this really excellent building material.

Fig. 36—Forest Hills Gardens, New York.

After considering the all-concrete buildings and the buildings in which other material has been used for ornamentation, it is interesting to turn to work where the latter condition has been reversed and is well illustrated by the work of S. T. Yourtee on the Kingsbury Apartments in St. Louis (Fig. 41). The blocks were cast in sand molds, and on account of the surface given by this method, subsequent treatment was unnecessary because of the peculiar matte surface which the rough sand mold provides (Fig. 42). Very intricate figures are easily worked out by

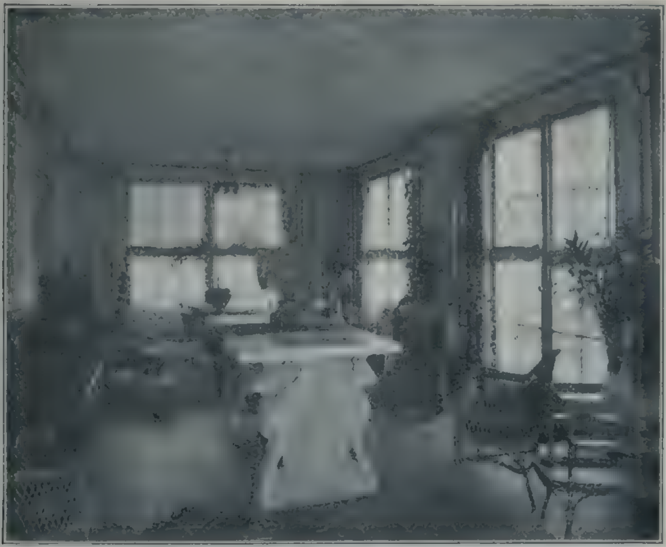


Fig. 37—Interior of Gage E. Tarbell's residence, Garden City, L. I., showing substitution of fresco for lattice.

this process and many buildings in St. Louis attest to Mr. Yourtee's skill in handling concrete.

Another prominent figure in the manufacture of decorative concrete stone is the Economy Concrete Company of New Haven, Conn.; which has begun at home to demonstrate the possibilities of concrete for furnishing the ornamentation for buildings of other material. Some of the most interesting work which this company has done, and that which it prizes most highly because of the personal interest, can be seen by all those who visit the home office, where the fireplace is composed principally of ornamental concrete stone (Fig. 43). The figures above the mantel are molded after the various workmen about the plant, with the exception of the one at the far right, who represents transportation. The other figures represent in their order (1) the draftsman laying out the plan, (2) the sculptor working over the pattern, (3) the laborer pouring the concrete, and (4) the workman putting the finishing touches on the surface and correcting any flaws caused by removing the forms.

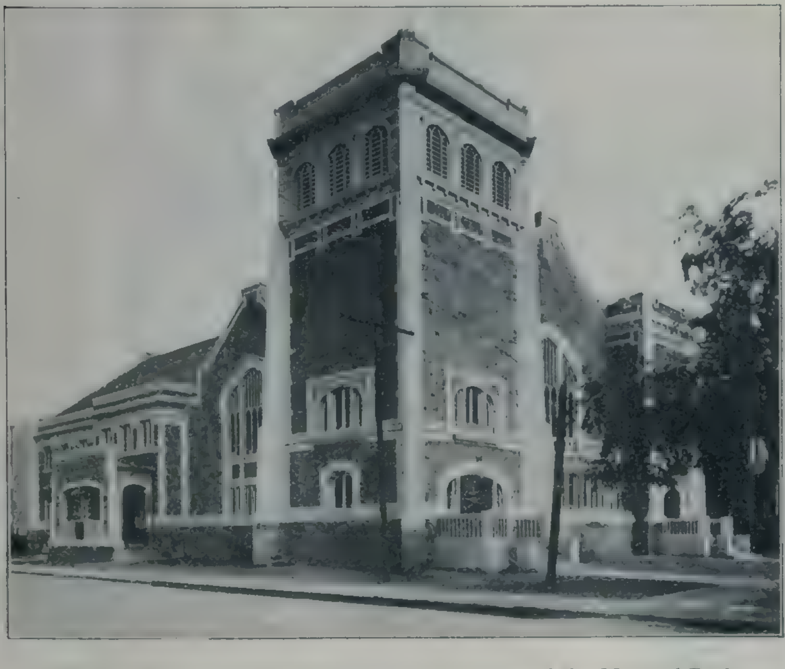


Fig. 39—Concrete blocks in the construction of the Normal Park Methodist church, Chicago.

The work is all cast in solid and uniformly proportioned concrete without special surfacing, using wooden or plaster molds. Where necessary, glue molds are employed for the under-cut work. This, of course, gives a rather smooth surface and is the only criticism which could be made of the product. With but slight additional expense, however, the surface can be chiseled so as to relieve what sometimes appears to be a rather putty-like surface when fresh from the molds. .

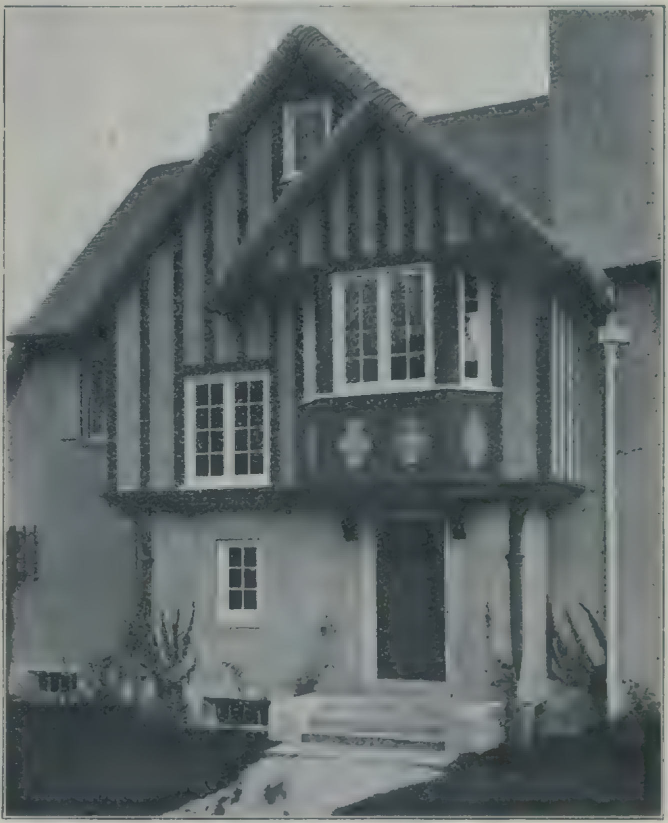


Fig. 38—Residence, Jamaica Estate, L. I.

The work of this company has favorably impressed such architects as Cram, Goodhue & Ferguson, who designed a number of buildings at West Point, including the gymnasium and cadet barracks (Fig. 44). In these structures all the stone work above the first storey has been cast by the Economy Concrete Stone Company. The close scrutiny which the government gives the building materials it uses is well recognized and the use of concrete stone in so important structures is a strong recommendation for the material. On the interior, all the stone decoration is of concrete, including appropriate relief panels of athletes at various sports (Fig. 45).

The chapel of St. Paul's Church at New Haven, Conn., has furnished another apportunity for this company to demonstrate the superiority of its product, as concrete stone has been used for decorating the old granite structure over 75 years old (Fig. 46). Just lately, the opportunity presented itself to brighten up the old building with concrete, and how satisfactory has been the result is self-evident.

It should make no difference whether the stone trimming is artificial or natural, the end achieved is that upon which we should pass

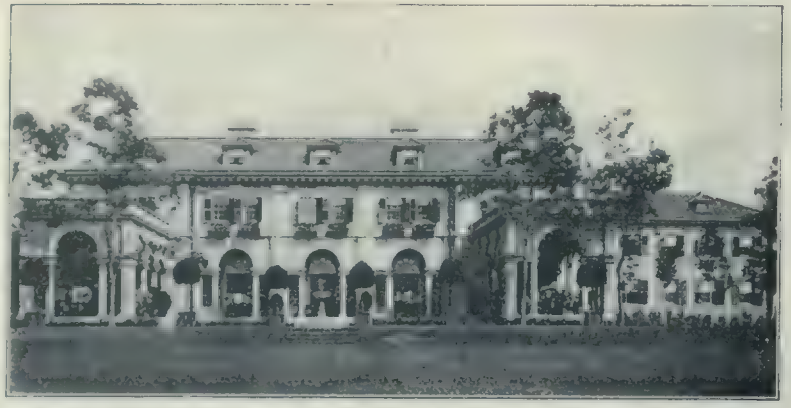


Fig. 40—Residence of E. S. Harkness, New London, Conn., built of concrete blocks.

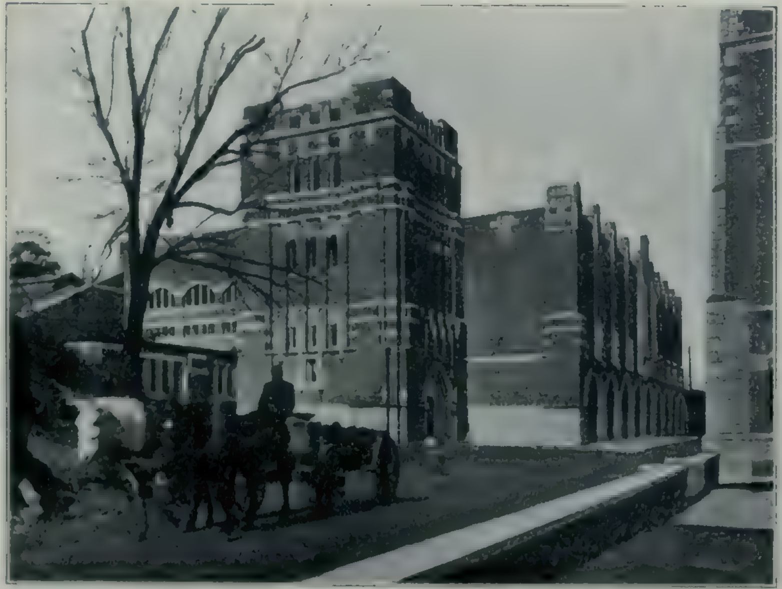


Fig. 44—Gymnasium, U. S. Military Academy, West Point. All trim above the first storey of concrete stone.

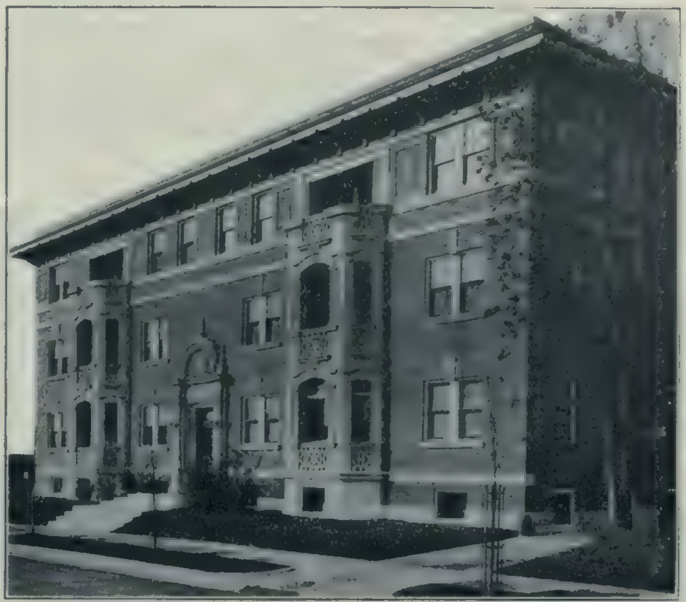


Fig. 41.—Kingsbury Apartments, St. Louis, Mo.

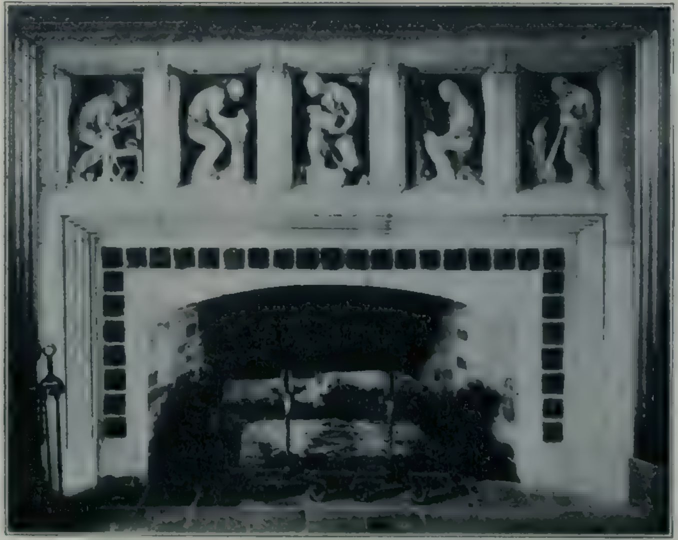


Fig. 43—Fireplace detail, Economy Concrete Company, New Haven, Conn.

judgment. In reality, it matters not whether the aggregate in the concrete has been bonded by nature, or by the hand of man with Portland cement as the binding material. So far as permanence is concerned, concrete has already proved beyond a doubt its superiority to many of the natural stones.

St. John's Church is built of a local trap rock which is of a natural gray surface (Fig. 47). But mingled in through the walls are many stones which are rusted, giving a weathered effect, which unobtrusively accentuates the concrete ornamentation, carried even through the tracery of the windows and the tower, and is much in evidence on the interior.

Another instance of concrete applied to ecclesiastical architecture is found in the Broadway Presbyterian Church of New York City (Fig. 48). The natural stone walls of the building are of New York gneiss laid up in random ashlar, and all the trimming, including the window tracery, is of concrete stone. This was cast in sand molds by the Onondago Litholite Company, of Syracuse. The aggregate used for manufacturing this particular stone is made from Gouverneur marble, a hard calcite product from northern New York. This flinty material in crushing, breaks into sharp angular pieces, which are graded into several sizes, depending upon what work they are to enter. After removal from the sand molds, the concrete is carefully cured and then tooled and surfaced by machinery. The surface obtained is identical with natural stone—but oftentimes is superior to it, because of its greater ability to resist the action of the elements. Conclusive evidence of this characteristic is to be found in the old sandstone decoration on the Konigsbau at Stuttgart, erected about 30 to 50 years ago. The upper cornice was ornamented by a number of large figures which began to disintegrate, making replacement of some of the parts necessary from time to time. As a final remedy, the officials proposed duplicating the figures in concrete. This decision was arrived at after inspecting several artificial stone figures which had shown practically no deterioration after 20 years of exposure to the elements. The surface of the new figures was tooled after coming from the forms so that they were identical in texture with the discarded sandstone models.

The Universal Portland Cement Company attempted something unusual in the construction of its new office building at Buffington, Ind. (Fig. 49). The building is of plain faced concrete blocks with the monotony broken up by the insertion of smaller squares and bands. The surface is further brightened by a ground surface finish which exposes the limestone aggregate and adds life.

In Boston, an imposing memorial showing tooled surface has been erected in Post Office Square (Fig. 50). This pleasing combination of cast stone with monolithic concrete was erected by Emerson & Norris and designed by Messrs. Peabody & Stearns, all of Boston. The monument is supported on reinforced concrete piles and the central portion is faced with cast stone, but the shaft was cast in place and afterward bush hammered to match the ornamentation. For aggregate, a mixture of granite, white and black marble, was used, which when exposed gives a sparkling and contrasty surface, displaying the combined characteristics of the individual materials.

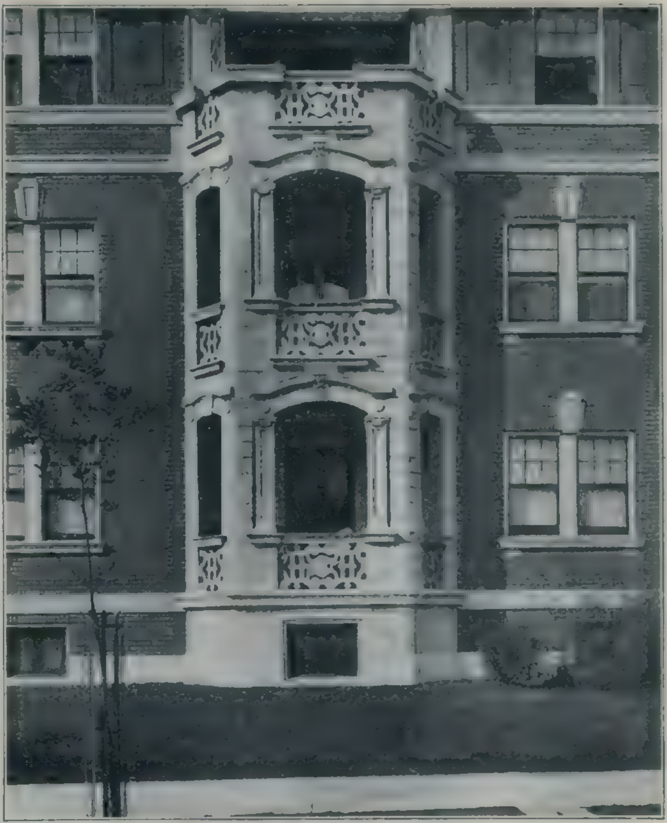


Fig. 42—Detail of concrete trim on Kingsbury Apartment Building, St. Louis, Mo.

The writers, not being architects, have dealt somewhat sparingly with the subject of architectural and decorative possibilities of concrete and have rather depended upon the illustrations to indicate the purpose of this paper. After all, architecture and architectural decoration is a peculiar study. On the one hand, we have those who contend for close adherence to the ancient styles of architecture, and on the other hand, we have many brilliant minds who have achieved wonderful results and designed some of our most pretentious structures along entirely new lines, yet without voluminous criticism from those who consider themselves authorities. However, since this paper has dealt more particularly with the architectural side of

Fig. 45—Interior of Gymnasium, U. S. Military Acadamy, West Point.

concrete, it is, perhaps, fitting that we close with a quotation from Oswald Hering, who has made a study of concrete and its architectural and decorative possibilities, and who, by the way, is a son of Rudolph Hering, an honored member of the Western Society of Engineers:

"Concrete can be easily and rapidly manipulated. It is less expensive than either clothed steel or masonry construction alone; it does not deteriorate with time and it is practically fire and waterproof. It grows in strength for a considerable length of time and after having attained its ultimate strength, it never weakens, consequently, by its use, lighter, cheaper and more durable structures may be erected than with any other known materials."

Regarding concrete stone he says:

"The time would seem to be not far distant when concrete will very largely supplant marble and stone where castings are practical. These should not be termed 'imitations' of stone, for the ingredients are largely the same as are found in real stone. Nature's process of employing time and gravity has simply been superseded and accelerated by man's mechanical ingenuity."

DISCUSSION

Mr. Boynton.—We found many points of interest in preparing this paper. The work of the Economy Concrete Stone Company is of particular interest because they have developed a type that they insist on making one way; if the architect likes it he can use it, if not, he can leave it alone. I think that is one reason why they have succeeded so well in getting a product that is uniform and really desired by the architect because it is dependable.

The Economy Concrete Stone Company cast their product in the different molds necessary to get the lines desired and then rub the product with rubbing stone, carborundum, or whatever is necessary to expose the aggregate product. When I last visited their plant they had a large piece that they were casting for a Government hotel at Panama. The Government holds this company in high esteem, because of the quality of the stone they are producing.

The work that the Emerson & Norris Company are doing is wonderful in that they have practically displaced building stone for entrance decoration in Boston. There are block after block of apartments in which all the entrance work and all the stone trim from the ground up to the window-sill, on the first floor, is cast stone or concrete stone rather than natural stone. Natural stone is no longer "in the running" where other stone can be obtained, because the latter is more uniform; it is more economical, because it can be cast in practically the shape and form required and thus reduce the cost of cutting to a minimum. This does not mean that it is sold cheaper because it is less attractive or less desirable (it is really more attractive and more desirable), but being influenced by the cost of the product it results in economy.

The Germans have been replacing with concrete, for twenty years or more, all the old stone work that has deteriorated. The stone work referred to as being now replaced with concrete was mentioned last December at the annual meeting of the National Association of Cement Users. A gentleman from Germany was in this country at the time, who had some lantern slides showing work in which they were replacing figures on the top of some of the German Government buildings. Some of the pictures showed where they were replacing with concrete the old sections of heavy stone columns which had deteriorated, retaining the form and texture and color. He said it was not at all uncommon to do that.

Question.—Where cutting of the cast stone is necessary, can as delicate work be done as on the natural stone, or is there a tendency of the material to spall or crumble under the chisel?

Mr. Boynton.—I believe good concrete will not spall as readily as natural hard stone. You doubtless have noticed some effects of concrete blocks (for instance, such as Mr. Hering referred to) where sufficient water had not been used in mixing the concrete, and where the blocks had been improperly cured, etc. That results in a crumbly product and chiseling is impracticable. In fact, the ends could be rubbed off with the finger. But a well-made concrete product can be worked in a manner similar to that of good building stone. The way it will cut will depend somewhat on the age and the size of the aggregate. If made of large aggregate it would require more time, so as to resist the tendency to break through the aggregate at a point not broken by the chisel, but after it is properly aged the size of aggregate makes no difference. If a product were to be chiseled it would naturally be made of finer aggregate; that is, ¼ to ½ in. rather than 1½ in. stone. There is no danger of properly-made concrete spalling or crumbling after it has reasonable or proper aging.

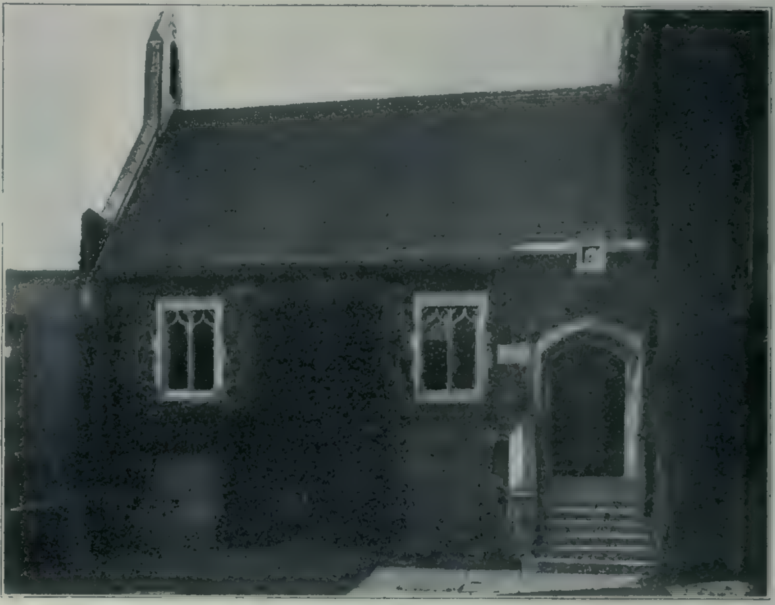


Fig. 46—Chapel of St. Paul's Church, New Haven, Conn. Window tracery of concrete stone.

President Reichmann.—About how old must concrete be before it can be worked with a chisel?

Mr. Boynton.—If necessary, and the concrete were cured under steam, it could be chiseled in a week's time, if made with that in view; but under ordinary circumstances with normal aging under normal temperature and with water only, I think it could be chiseled safely in thirty days.

Question.—I would like some information as to how the ornamental tiles are applied. Are they placed in the forms before the concrete is poured, or, if not, are blanks for them provided, and the tiles subsequently inlaid? Also, is any material or backing or mechanical bond for them necessary?

Mr. Boynton.—It is usually the practice to put a blank in the form, outlining in a general way the shape of the figure or the tile that is to be set in, having the blank the same depth as the piece to be set plus a light mortar backing. Then with careful setting, thorough moistening of the con-

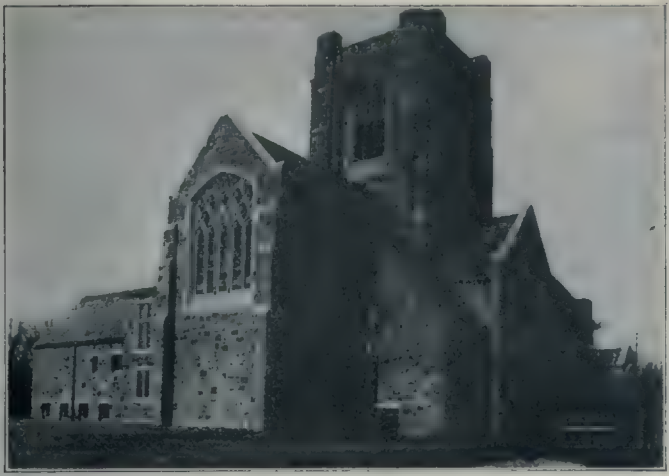


Fig. 47—St. John's church, Hartford, Conn. All trim and tracery of concrete stone.

crete, and careful placing of the tile in the proper mortar, it adheres firmly.

Question.—What material was used in stenciling the interior of the building that represented the lattice? Was it paint?

Mr. Boynton.—I presume it was. There are a number of formulae that will produce good paint for painting on concrete, even on green concrete. Any form of linseed oil paint can be used, if the concrete is thoroughly aged. But we never know exactly when it reaches that point and we are apt to want to decorate the surface before that time. With the use of the proper formula it is perfectly safe to paint concrete as soon as it ordinarily dries out, say in thirty days' time.

Question.—Must the paint be something special?

Mr. Boynton.—Yes, but it is an inexpensive paint. Linseed oil on concrete may prove troublesome and have to be removed.

Mr. Stineman.—The statement is made in the paper that pleasing architectural effects may be made in concrete with very little or no additional cost. That is something which engineers should bear in mind, because many of them are inclined to the belief that anything which looks well will cost too much. As a result they erect buildings which are nothing but walls with holes in them, and bridges and structures that are unsightly from an architectural standpoint. They say, "We will put up the structure so it will hold and do the work, and never mind how it looks." Yet with the same or a little more money a pleasing architectural effect might be had. I notice among the illustrations several viaducts in this city, plain in surface or plain in line, which have a pleasing effect because some architect or some man who understood architecture designed them. I would not go so far as to say that engineers should be architects or should make a study of architecture, but I believe engineers should either learn something about architecture or else, in the case of structures which are built in places where people must look at them for years and years, engage an architect to design for them, if they are not able to do it themselves.

President Reichmann.—I think that is a very good point. It is only within the last few years that engineers have ceased using most of their time developing new theories for the engineering profession. We are now spending a little more time developing architectural effects of our designs. Years ago, an attempt in the line of aesthetic design in connection with factories was immediately cut short; the owner would not allow the engineer to put anything on the structure in the wory of ornamentation, because it would cost a few dollars. But we are now approaching the time when there is more willingness to give the structure attention from an aesthetic standpoint. I believe the engineer is capable of doing this, but heretofore he has not been permitted to do it. There is a great difference in the factory of today and the one built twenty years ago. At the present time, the light and the general features are thoroughly considered before the work of planning is started.

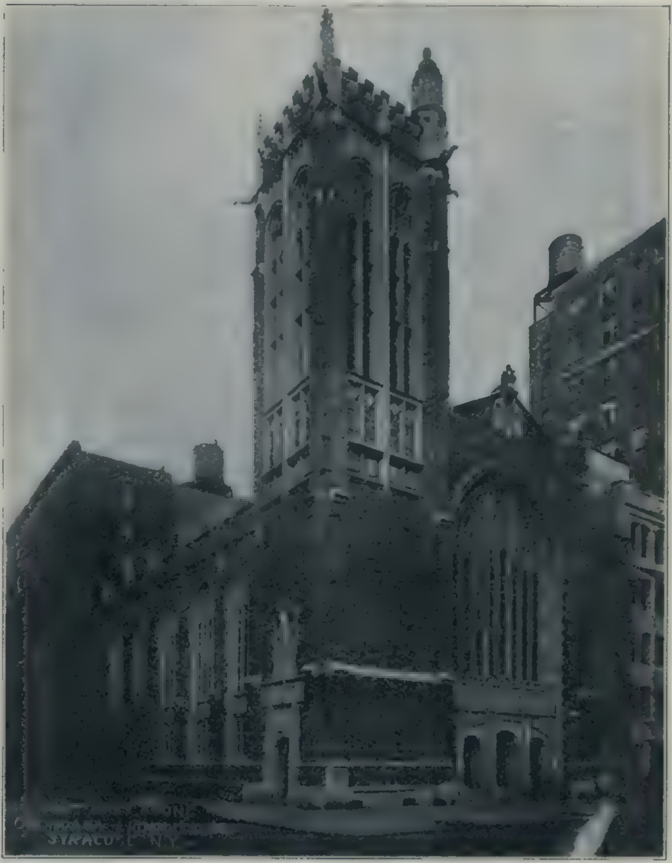


Fig. 48—Broadway Presbyterian Church, New York City.

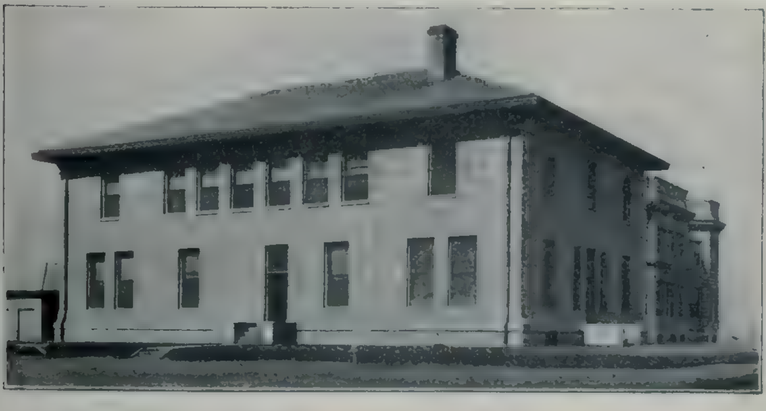


Fig 49—Office buildings, Universal Portland Cement Company, Buffington, Ind.

Mr. Boynton.—Regarding the work of Mr. Squires in New York, there is one point I might mention as to getting the decorated ceiling effect by using inverted sand molds for the forms. We tried to secure a photograph of the finished ceiling, but had to give up the idea after making several efforts, because of the difficulty in getting back far enough and securing the proper lighting.

In that work Mr. Squires has gon a step forward, I think, in that he will get all the strength he requires through the beams between the decorations.

He will also do away with the plain ceiling at a cost that will be taken care of by the cost of a plain ceiling. He says the cost of building such a ceiling is practically nothing, over the plain ceiling. He saves weight with his structure—saves all the way down the line—and he has a decoration when he gets through that is attractive. Those things are well worth our consideration, and doubtless many of us in every-day work will see how by study we can get some decoration or pleasing effect without adding materially to the cost; possibly decreasing the cost. Mr. Squires is an architect and not an engineer; that is, he is practising as an architect, and his work has been confined very largely to residences and apartments. But the same principle can be used in other buildings where a decorated ceiling is desired or there is any desire or need for breaking up the monotony of a ceiling. The cost of such work will doubtless be a little more until we become accustomed to it, or until we have men trained to making the blanks.

Fig. 50—Angell Memorial, Post Office Square, Boston.

One thing that has kept us back and interfered with the proper development of concrete, is that the man who makes the initial expense must necessarily be at more expense than the one who comes after him. We find this in building houses. For instance, in building houses at Gary, the first year's houses cost much more than the second year's work. The saving the second year was astonishing, and it was due to the fact that a trained organization had been developed the second year, avoiding delays and in many ways effecting savings.

The point we have tried to bring out in the paper is that in concrete we have a material from which we can get results. The only real lesson we have tried to teach is that in concrete there are great possibilities for beauty, and this beauty can be brought out by giving a little thought and study to the matter.

The Movement of Tall Buildings

THE recent statement of the Superintendent of Buildings of Chicago that virtually all of the immense buildings and skyscrapers of the downtown district are out of plumb, calls attention to a peculiarity of tall buildings little realized and still less understood outside of the architectural and engineering professions, says Building Progress. The common impression is that all heavy and massive structures are rigid, firm, and immovable; yet, in Chicago, according to the Department of Buildings they have not one but scores of buildings like the leaning tower of Pisa, only they do not lean so much, thirty inches being the most that any of them are out of plumb.

So far from being perfectly firm and rigid, all tall buildings are subject to two distinct movements, and all heavy buildings erected on anything but bed rock have three distinct movements to their credit.

The city of Chicago, built as it is on sub-strata of clay, furnishes the most interesting study of the movement of buildings, and the greatest number and variety of examples. All of the early skyscrapers of that city were carried on floating foundations or on piles driven deep into the clay. These buildings without exception settled into the soil due to their weight, the distances they settled varying from three to over five inches. Many of these buildings, notably the Great Northern Hotel, are partially carried on jacks and periodically levelled up as settlements occur, then, after all subsidance has taken place, and the buildings have finally come to rest, the jacks are removed and the foundation walls filled in with masonry.

That is one of the movements of buildings, then, settlement; but settlement takes place only in those buildings erected on floating foundations. When the footings are extended down to bed rock, as all footings for present day buildings in Chicago are, the amount of settlement that takes place is nil and may be disregarded.

But even buildings with their footings carried to bed rock lean or are racked out of plumb, and the taller the buildings the more they are likely to lean, although the amount they are out of plumb is seldom enough to endanger the structure. Recently the Building Commissioners of Chicago ordered the Unity Building straightened as it was "unsafe but not dangerous," being thirty inches out of plumb. In an interview they said: "It is impossible to prevent the big buildings here from leaning. Some of them are not straight when they are finished, but that does not impair their safety. It is probably safe to say that every building in the city leans more or less. If they are on floating foundations they also settle gradually." But there is still another movement of buildings, and the most interesting of them all to consider. According to an exchange, "The Eiffel Tower swings perceptibly in the wind, and even stone shafts like those of the Bunker Hill and Washington monuments move several inches at the top. In these cases the cause of the action is not only the wind, but the heat of the sun. The side that is towards the sun expands during the day more than the side in shadow. An interesting device has been employed to show the movement of the dome of the Capitol at Washington. A wire was hung from the middle of the dome inside the building down to the floor of the rotunda, and on the lower end of the wire was hung a 25-pound plumb bob. In the lower point of the weight was inserted a lead pencil, the point of which just touched the floor. A large sheet of paper was spread out beneath it. As the dome moved, it dragged the pencil over the paper every day. The mark made was in the form of an ellipse six inches long. The dome would start moving in the morning as soon as the rays of the sun began to act upon it; and slowly, as the day advanced, the pencil would be dragged in a curve across the paper until sundown, when a reaction would take place and the pencil would move back again to its starting point. But it would not go back over its own penciled track, for the cool air of night would cause the dome to contract as much on the one side as the sun had made it expand on the other, and so the pencil would from the other half of the ellipse, getting back to the original point all ready to start out again by sunrise."

In the three movements affecting tall and heavy buildings we have, then, particularly in the expansion and contraction movement which is of daily occurrence, and which affects skyscraper buildings as well as all other tall structures, a condition which must be taken into consideration when planning the buildings. Lines of steam pipes, stacks of draining pipes, lengths of water pipes, vacuum cleaning pipes, refrigeration system pipes, electric wire conduits and the various networks of tubing which cross and criss cross inside of a building will naturally be more or less affected by the movements of the building; and if long life is expected of these various systems of piping, they must be so installed that they can "give" under the movements of the building without damage to the piping, and sufficient to compensate for the change of position.

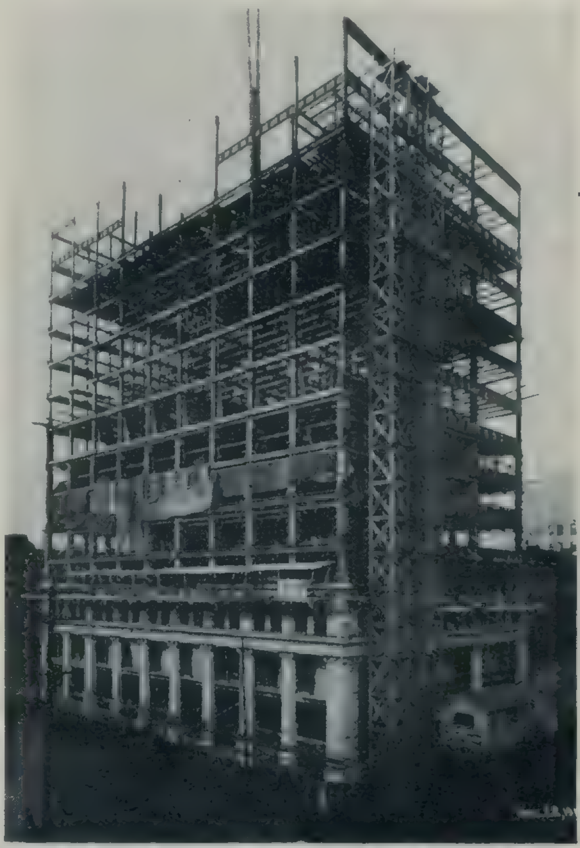
Besides pointing out the necessity for flexibility for the piping systems in tall buildings, the movement of buildings shows how desirable it is to have solid foundations the footings of which extend down to bed rock. Floating foundations are all right for some kinds of buildings, but for the skyscraper type there is nothing so good as the solid rock of old Mother Earth.

Blasting pole-holes in frozen ground has proved more economical than hand digging to the Marion Light and Heating Company, of Marion, Ind. Whenever the ground is frozen to a greater depth than 2 ft. this company digs the hole, exact size, about 15-in. deep only. With a long-handled auger a hole large enough to admit a stick of dynamite is bored about 30 in. deep. It has been found that three-quarters of a stick of dynamite will excavate a uniform hole to the desired depth of 5 ft. An average saving of 15 to 20 per cent. over the cost of manual digging has justified this method.

Freight traffic through the two United States and Canadian canals at Sault Ste. Marie in 1913 was the greatest in the history of these waterways, according to a recent report by L. C. Sabin, general superintendent of the United States canal. Freight totalling 79,718.344 short tons was handled during the season, or 7,245,668 tons more than during 1912. Only three commodities show decreases—lumber, copper and manufactured pig iron. Vessel passages numbered 23,795, as against 22,778 the previous year. The number of passengers carried totalled 77,194, as compared with 66,877 in 1912.

The New Weart Block, Vancouver

THE accompanying view illustrates in striking fashion the proportions of the new fifteen-storey Weart Block, the largest building at present under construction in British Columbia. This structure is being erected in Vancouver at the corner of Hastings and Richards streets, unquestionably one of the very best sites for an office block in the city. The frontage on Hastings street measures 78 feet and the depth on Richards is 120 feet. The foundations have been carried to rock 25 feet below grade and the basement is fully waterproofed. The construction consists of a heavy steel frame and concrete, the exterior facing on the three lower storeys being terra cotta with a polished granite base. The succeeding eight storeys will be of face brick, and the exterior of the four top storeys is to be treated in terra cotta. The spaces between the piers of the two lower storeys are to be finished in marble and bronze. The main entrance corridor has been designed in the same architectural style as the exterior, the walls and floors being of marble with bronze trimmings and ceilings of oak beams and panelling. The main floor is planned so that the corner can be utilized by a banking institution with the main entrance on Hastings street.



The 15-storey Weart Block, Vancouver, under construction.

The main corridor will be entered off a general vestibule 25 feet wide, which leads to the basement stairs on one side, and the bank entrance on the other. The corridor floors will be of terrazzo tile, with marble borders and oak will be employed as interior finish throughout. The typical floor will be occupied by thirty offices. An approximate expenditure of $700,000 has been estimated for the building, which is being erected by the Canadian Ferro Concrete Company, after plans by Messrs. Russel, Babcock & Rice, Vancouver.

Organizing and Executing the Construction of a Reinforced Concrete Industrial Building—Part II

By Leonard C. Wason

THE contractor is very largely a broker buying materials to be incorporated in a building. Some materials are easy to buy and some require a detailed knowledge of the materials themselves and also of the estimate and contract and the relation of one class of material to another. Therefore there is a distinction made between routine buying and experienced buying. Of the routine buying, some can best be done locally from the job and some from the main office of the company. There has been compiled a complete list of all materials which enter into a job, and then it is decided which of the routine items can most advantageously be bought by the main office and which by the job superintendent, and written instructions are prepared for these items.

Lumber and steel schedules are generally the first to demand attention. Lumber used in contact with cement is almost always ordered planed four sides. A correct ordering schedule for lumber cannot be made, of course, until the work of detailing forms is nearly completed in the drafting room. It is possible, however, to make an approximate schedule for canvassing for prices. By referring to standards we are generally able to tell in advance what sizes are wanted, and are ready to order material forward as soon as centering details are completed. As lumber arrives the material of different dimensions, qualities and finishes is piled by a prearranged plan worked out in the office handy to the woodworking shop and given numbers or letters obtained from the key plan.

The steel is taken off the plans by one man and checked independently by another. This schedule is then studied in regard to reducing the variety of lengths, and frequently these can be reduced to one-fifth of the number shown on plan. It is usual to order a schedule of bars ¾ in. and larger in multiples of 6 in. and to buy steel ⅝ in. and under in the longest lengths that can be put on a single flat car, and cut it up on the job. The largest sizes recommended are 1¼ in. square and 1⅜ in. round; the smallest ¼ in., all sizes to be multiples of ⅛ in. On one large job there were over 400 different lengths of bars shown on plans, and by scheduling large bars in multiples of 6 in. and ordering small bars in long lengths, as above described, the mill order was reduced to 46 different lengths. This method only increased the weight of the order so as to cost $18 in excess of the exact schedule taken from the plans, a sum saved many times over in the greater convenience of sorting and handling the steel. The manufacturers are required to deliver the small bars in bundles weighing from 125 to 145 lbs.; this insures the men getting a load of proper weight for greatest efficiency.

A study of comparative costs on different buildings indicates that about 35 per cent. of the money spent is for labor, over one-third of which is consumed in the making up, erection and stripping of forms. This, combined with the fact that lumber and labor are continually advancing in price, would indicate that a very careful study devoted to reaching the greatest simplicity and regularity in making up panels, and of using the lumber with the most efficiency, is a vital factor in low cost work. By "panel" is meant several boards cleated together so as to be handled as one piece. To gain this efficiency the study of the forms should not be left to carpenters, but it should be the sole work of a corps of men trained to think forms all the time.

The Plant

Study of the amount and location of mechanical plant has to be made immediately after the contract is awarded if work is to be started promptly, as part of it is put into operation with the very beginning of construction. As a good deal depends upon the amount, design and promptness of delivery, so far as economical construction goes, the best thought of the whole organization is put on the subject. For instance, one of the younger men made a study for a large job on the basis of a storey a week. To obtain this rate one mixer and two storeys of forms more were required than if the progress was slowed down to a storey in nine working days. Such speed was not demanded. A conference of all hands corrected the first study, making an estimated saving in job cost of about $10,000.

The method of distribution of concrete through the building requires some consideration. If a building is compact and large masses are placed within a limited area, spouting is desirable. If the building is spread out and quite small quantities of concrete used, two-wheeled pushcarts are used, while if large quantities are required over quite an area, industrial tracks laid on horses so as to elevate them about 18 inches above the forms are run over the latter to distribute concrete a batch at a time.

After the job superintendent is determined upon, he is taken into consultation for every step which follows. The selection of all his subordinates is made in co-operation with him—assistant superintendent, clerical force, carpenter, labor, concrete, steel and other bosses; the principal mechanics and even the leading laborers are all selected in advance from among those working on other jobs. The superintendent, where possible, is given at least a week to study plans and specifications in co-operation with his principal assistants and the office force, before anybody appears at the site of the work except for the mere purpose of studying local conditions. By this time a well-defined plan has been worked out as to the sequence of various operations, the type, size and location of the mechanical plant; schedules of the materials first needed have been made and orders placed, so that by the time actual operations begin in the field the plans are so matured that there are few false moves. The peak of the superintendent's load is the first few weeks during the organization and starting the work. During this period he should have his full executive force, although each subordinate may not at that time be doing nearly as much as he will be called upon to do later.

Planning, Routing and Cost Accounting

During the early stage of actual construction the superintendent makes a careful study of the handling of the work from the beginning to the very end, making a detailed schedule of work along the general lines which had been previously determined in the office.

The job office work is in charge of a chief clerk, who, in addition to overseeing the work of the material clerk and timekeeper, has also charge of the cost-keeping. He figures from the time sheets the cost, of which two records are kept, one for the superintendent's use in card index form, covering every single item on the job, the other considering only the large items, such as concreting floors and columns, placing reinforcing steel and for work for floors, columns and beams. The latter costs are recorded on cross-section paper. These diagrams are posted where the man who has full charge of each item can consult same when convenient for him. The foremen take a particular interest in these. Figures meaning a little larger or smaller cost convey some idea to them, of course, but the meaning of a line traveling upward or downward and above or below a red line representing the desired cost line is grasped very easily. Keeping the foremen keenly awake to the cost of the work they are doing has not been, so far as can be seen, detrimental to their turning out good work. It should always be accompanied, however, by more rigid inspection in the beginning and explained so that they may definitely understand that any lowering of cost shall be considered detrimental to their interest unless the quality remains equal to the standard.

Moving Boss and His Gang

The moving boss and his gang are a very important factor in the success of routing. He must be a painstaking, tireless fellow, who has sufficient intelligence to see that the men under his charge do exactly as told, taking the correct materials, carrying them to the proper place and laying them right end to and right side up, as per the written instructions from the routing foreman. The men under his direction must be active, strong and energetic—the pick of the laborers, because they have to do a great deal of moving about and are in small groups or alone; therefore, they are not under the close eye of their foreman. They must be men who will work without being too closely watched. This boss receives instruction as to how such laborer will do his work from the operating foreman.

The method of task and bonus pay is frequently followed on work, and by means of data previously obtained it is possible to ascertain very accurately what the correct best time should be for the making up of any particular panels by a pair of good carpenters. For doing the work in this tasked time an increase over their usual hourly wage is paid of from 25 to 30 per cent. On the erection of the form a similar method is followed. All material is moved from the stock piles to the point of erection by common laborers, under the leadership of an efficient moving foreman. The foreman receives all instructions on a written slip. The planning department is able at all times to make sure by so doing that the carpenters have the material they want, when they want it, and where it will be most convenient for their use. No carpenters are allowed to carry lumber, but are restricted to doing real carpenter work.

In spite of the wages of carpenters nearly doubling in twenty years while the equality of intelligence of those who do the work is less, because house and finish carpenters will not do this kind of work as formerly, and in spite also of the great advance in price of lumber, combined with a falling off in quality, the unit costs obtained by the above system are materially lower than when the job superintendent was left to himself. The total gain in efficiency is about fourfold.

It is unnecessary to protect form work from the rain, as usually it is only possible to get green lumber, whose tendency is to shrink out of shape rather than swell. Rough concrete never need be protected from the rain before setting, only from the concentrated run-off over some portion of the work which might wash deeply the cement out of a small area.

A troweled finish, however, must be protected against pitting by the rain or damage by concentrated streams. This is usually done by tarpaulin, which consists of 12-oz. cotton duck rendered waterproof by being saturated with "Preservo," after being made into covers twenty feet square. These are supported by temporary frame. They are somewhat of an inconvenience to the finishers, and decrease the amount of work which they can do.

If there is to be an unavoidable delay in placing concrete after forms are erected it is wise to protect them from the sun, because they shrink so as to open up cracks, which permit the mortar to escape, leaving a bad surface. Rough concrete does not require any protection from the sun, with rare exceptions. It is usual to cover up a granolithic finish for at least five days. The materials most available and most economically used for this purpose are rough bags, such as come around bales of cotton, or wool, shavings, sawdust, and sand. The object of these is to retain the water which is put upon the surface, which may thus be maintained at a fairly uniform lower temperature than direct sun action permits while setting.

Mr. Wason considers it unwise to spray bare concrete in the hot sun, and the use of roofing paper is but little better, because it retains moisture but a very short time. The water falling on a surface heated directly by the sun chills it suddenly, causing it to shrink, and may cause the very cracks which one is trying to avoid.

The aggregates must be free from frost when mixed. A live steam pipe can be shoved into the sand pile, the escaping steam heating it and removing all frost. The same may be done with the stone, but a canvas should be thrown over the top of the pile to retain the heat, which more readily escapes. Where a considerable amount of heating is provided for in advance, steam pipes are laid on the ground, and stone as received is dumped upon them. Then there is a canvas thrown over to prevent storms getting into the pile, and to retain heat. The frost is thus easily and economically removed.

Salt is frequently used in the water to lower its freezing point. It is seldom worth while to heat the water itself. Little care need be used to prevent mass concrete from freezing, as the frost will usually only strike to a depth of about 1 inch. Buildings are inclosed with tarpaulin tied on to an outside staging, and the inclosed space is heated with salamanders burning coke. Sometimes it is possible to use steam.

Frost is removed from form work by the use of salt and steam, and if the concrete surface is left rough it is common to sprinkle the top surface with salt to prevent freezing. In winter it is very common to put the finish on as a separate operation, after the building is inclosed and not as an integral part of the construction, on account of the danger of freezing. When it is put on, it must be kept from freezing for the first forty-eight hours.

The expense of protection against the weather is not very great, and good results can be so surely guaranteed that it is not usual, Mr. Wason states, ever to discontinue work on account of cold weather.

Erection Features of the Quebec Bridge

St. Lawrence Bridge Company's Elaborate Equipment—Erection Travellers—Systematic Method of Building Various Parts of the Structure.

THE new Quebec Bridge is located at Neilsonville, at the site of the old structure, which is about eight miles from Quebec. The bridge has a center span of 1,800 ft., consisting of a suspended span of 640 ft. and two cantilever arms of 580-ft. span each; two anchor arms of 515-ft. span each; and approach spans, the total length of the structure being 3,240 ft. The new bridge is much heavier than the old structure, which made it impossible to use the old piers. The new piers for the main span are each 67 ft. south of the location of the old piers. The bridge has a clearance of 150 feet above high water.

The new bridge was designed and is being constructed by the St. Lawrence Bridge Company, which was organized to build this structure. The designing office is in Montreal, and the bridge shop is about five miles from Montreal, being about one mile from the Dominion Bridge Company's plant at Lachine Locks. The capital stock of the St. Lawrence Bridge Company is held equally by those interested in the Dominion Bridge Company and in the Canadian Bridge Company, and many of the officers of the new company are former employees of the latter companies. The bridge shop of the St. Lawrence Bridge Company is a new structure, and was designed expressly to build the new bridge. It contains considerable special machinery designed to fabricate the large sections of the new structure. The plant was built at a cost of about $1,000,000, and must be paid for out of the profits of the new Quebec Bridge.

The St. Lawrence Bridge Company has an elaborate equipment at the bridge site. The various bridge sections are unloaded from the cars by means of a large traveling crane, and are transported to the bridge site over the company's system of tracks. There is now stored at the site a considerable amount of fabricated material, principally for the floor system. The piers and abutments are now completed and the approach spans are in place. For constructing the piers at the north end of the bridge an inclined railway was built on each side of the north abutment. The material for the piers was transported to the site, where it was transferred to the inclined railway, which in turn carried it to the location of the pier. The material was then picked up by derricks and set in place.

Each of the cantilever arms is to be erected as a separate structure, with its individual erection equipment. The center span, which will weigh about 6,000 tons, will be assembled on barges near the bank of the river. It then will be floated into position, and by hydraulic power will be raised to its final position in the structure.

Each erection traveler for the cantilever arms is constructed of steel and is about 200 feet in height. The traveler is carried by four trucks having six wheels each. At its base it spans two railroad tracks, on which are transported the cars containing the material for the bridge. The total weight of each of these travelers is about 840 tons, although an attempt was made to make this weight a minimum by constructing the crane girders which project over the traveler of nickel steel.

The hoisting equipment of each tower is both elaborate and diversified. On each of the four corners there is a 90-ft. 15-ton derrick, and on top of the traveler there are two traveling cranes, each crane carrying two 55-ton main hoists and two auxiliary gantry cranes. On each auxiliary gantry crane there are two 5-ton hoists. All motions are motor-driven, except the bridge travel of the auxiliary gantries. The main traveler will be moved along the cantilever arms by using, temporarily, two of the 50-h.p. motors of the 15-ton derricks. Table I shows the distribution and capacity of the motors for one traveler. It will be seen that 26 motors, with a total horsepower of 752, are used for hoisting operations.

On each side of the river, high tension hydro-electric power is stepped down by transformers, and is converted into 250-volt, direct current at two sub-stations, one on each side of the river. These sub-stations are supplied by separate systems, and are connected by submarine cables. Each sub-station is of sufficient capacity to operate all the motors on both sides of the river, including those required for the air compressors, which requires about 1,600 horse-power.

Direct current is used exclusively on the erection towers, as it affords better control than alternating current, and permits the ready employment of dynamic braking for the lowering machinery. The lowering of some of the heavy members used in the construction of the cantilevers would generate an excessive amount of heat in any type of friction or mechanical brake. By dynamic braking is meant that the motors are temporarily converted into generators during the lowering operations, the different speeds being obtained by inserting or removing a series of resistances. This enables most of the heat to be dissipated in a cast grid resistance, which is located in the base of the main traveler.

The returning effect of the dynamic braking action, as applied to the lowering of a load, exists practically only while the motor armature is rotated. It therefore requires a separate means to hold the load stationary. For this purpose a magnetic brake is placed on the armature shaft to lock the motor when the controller is brought to the "off" position. On some of the hoist motors safety devices are provided to stop the motor automatically if the operator should allow the load to over-travel. A large switchboard is installed in each main traveler, and numerous push buttons are located at points easily accessible to the operators, by which they can open or close the motor circuits.

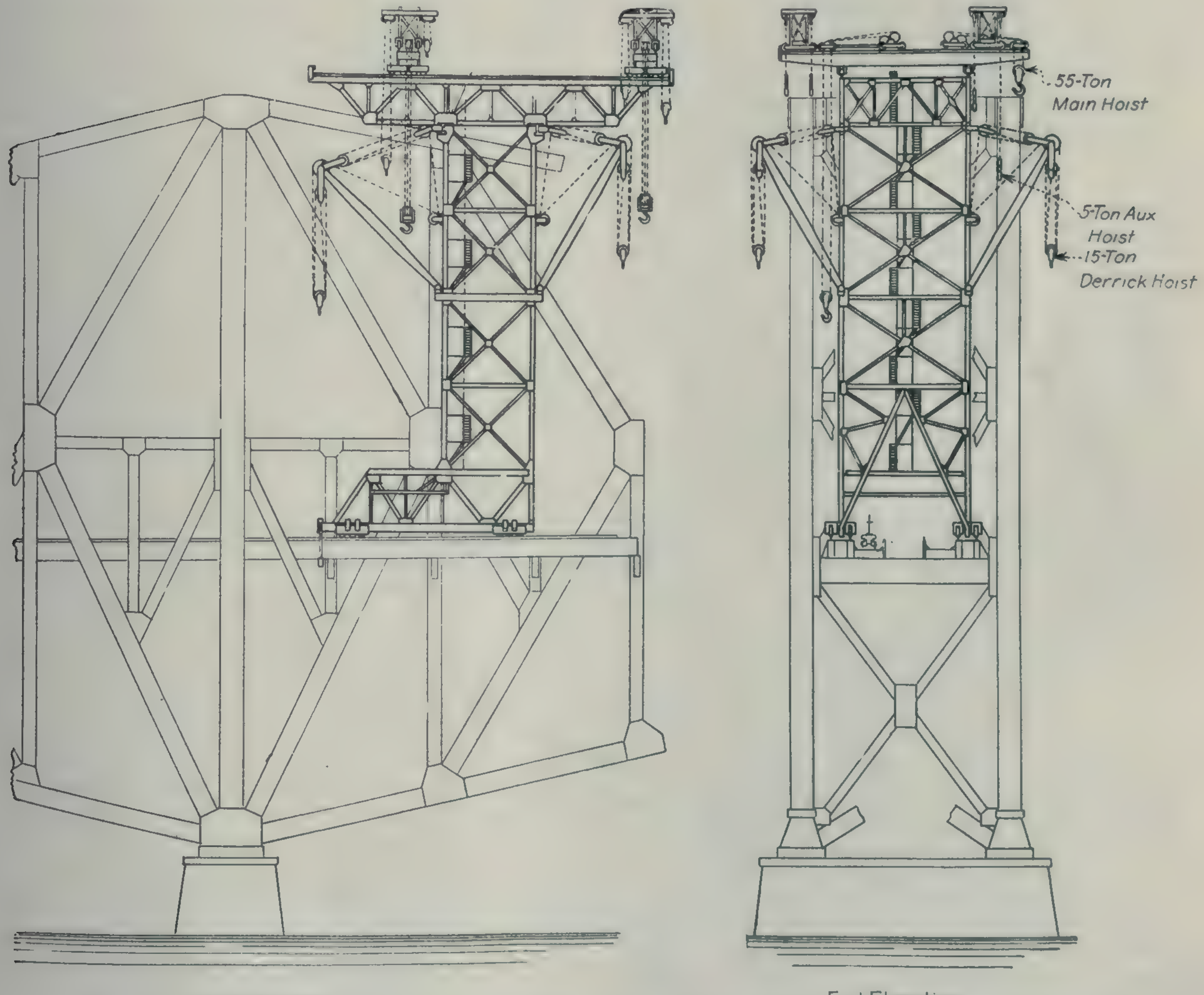
The two main trusses are to be erected symmetrically on each side of the main traveler. It is planned first to erect the north anchor arm over falsework, using one of the travelers. After this arm has been erected the south anchor span will be erected by using the second traveler. At the same time that the south anchor arms is being erected the first traveler will be at work on the north cantilever arm, and this will be finished at about the same time that the south anchor arm is completed. The first traveler will then be taken down and reassembled at a point about two miles below the bridge site, where it will be used for erecting the suspended span on barges. In the meantime the second traveler will be at work erecting the south cantilever arm, and it is planned to complete the erection of this arm and the suspended span (on barges) at the same time. The suspended span then will be transported to the bridge site and raised into place.

An operating platform will be built on each traveler at a height sufficient that a clear view can be secured of the material as it somes from the flat cars and is elevated into its final position. A house will be built in the center of this platform to protect the control apparatus, except that portion which is directly operated by the workmen—this will not be enclosed. Six men will be stationed on the operating platform and two men on each of the main cranes at the top of the traveler. To secure the proper co-operation between the widely separated workmen, a telephone system will be installed with a central switchboard and permanent connections with the shore. An electrically operated passenger elevator will serve the different levels of the traveler.

The following is a brief description of the method of erecting any typical part of the structure: The member first is brought beneath the traveler on flat cars, and is elevated and placed by two, or possibly four, of the 55-ton main hoists. The pin is then brought into position by one of the five-ton auxiliary hoists. A large ram for driving the pin is then brought into position by another five-ton auxiliary hoist, and the pin is driven into position.

It is expected that work can be prosecuted only for about eight months of the year. With this condition in mind it is expected that the bridge will be completed in 1918.—**Engineering and Contracting.**

Water purification at Albany, N.Y., where Hudson River water is passed through a sedimentation basin, preliminary filters, slow-sand filters and finally receives a dose of hypochlorites, cost $6.19 per million gallons, including pumping, during 1912, according to the report of Mr. J. B. Kilbourn, superintendent of the Bureau of Water. This cost is apportioned among the following items: Pumping, $3.19; sedimentation basin, $0.02; preliminary filters, $0.56; slow-sand filters, $1.15; laboratory, $0.61; hypochlorite, $0.35; superintendence, $0.31. During the year 7,600,456,000 gallons of water were treated. The average rate of filtration was 3,535,000 gal. per acre for slow sand and 81,000,000 gal. per acre for pre-filters.



Side Elevation

End Elevation

Fig. 1. Side and End elevations of erection traveller for new Quebec Bridge, showing type of Traveller and location of motor hoists.

Wood and Asphalt Block Pavements*

Failures due to Lack of Provision Against Bulging—Inadequate Attention given to Methods of Laying—Manufacturing Shortcomings

By H. H. Schmidt

PAVEMENTS are supposed to be designed to meet certain requirements. No one pavement is known that will meet all. If one pavement is best suited to the most severe conditions, it it not necessarily the best pavement for less severe ones. Somewhere in the scale of pavements, between the ideal one and the so-called pavement which is destroyed in a comparatively short time under light traffic and by the action of the elements, might be placed all known pavements in the order of their value. I will not attempt to tell you just where, in this scale of pavements, wood and asphalt block pavements should be placed, though I will say that neither one is the ideal pavement, except in the opinion of the respective manufacturer, and still both of them stand well up in this scale of pavements.

Wood Block Pavement

Wood block pavements are suitable for streets where the factor of elimination of noise is an extremely important one, and where the traffic is quite heavy. Probably every one who has had considerable experience with this class of pavement has obtained many splendid results, but also some failures. These failures in wood block pavements are entirely different from failures in any other class of pavement. They are due almost invariably to the expansion of the wood, and within a short time a perfect street may become a complete wreck.

Another source of great annoyance with this pavement, though not to my mind an extremely serious condition, is caused by the so-called bleeding of the blocks. This bleeding is always, where it occurs, a matter of much concern to the one responsible for the condition of the pavements. The bleeding generally ceases after the block has been down a few years. In no other pavements do we have these two conditions to contend with.

The important question, and the one which is occupying the minds of many who have to do with this class of work, is the expansion of the block. The nature of all wood is such that it expands or contracts as the amount of moisture to which it is subjected is increased or diminished. If it were possible to lay blocks in their most expanded condition, we should not have trouble with expansion after the pavement was laid, but it is very seldom that blocks are in this condition at the time of laying. For this reason we must give consideration to many matters which are involved when this class of pavement is used. Traffic, treatment of the blocks, their condition before treatment, their condition when laid, surface drainage of the pavement, the width of roadway, the amount of moisture or water to which these blocks will be exposed, and the length of time they are subjected to the wetting, are all matters which must be taken into account if failures are to be avoided.

It might be said that where failures in wood block pavements do occur, they are due to a lack of knowledge, or a lack of provision for the essentials which must be considered to provide against bulging under certain adverse conditions, and I look for fewer failures as these various matters are better understood and better provided for.

The specifications in use in the various localities in this country at the present time are, on the whole, very much alike, and there is no question but what they will provide for a wood block pavement which, under all ordinary conditions, will give splendid results. The important elements upon which the modern practice is based are: The character of the timber; size of the blocks; character of the oil, treatment of the blocks and method of laying.

More attention has been given to the size of blocks, character of the oil, and the treatment of the blocks, than to any other features of the wood block pavement. That they are very important questions it is unnecessary to state, and yet the character of the timber, its condition at the time of treatment, and the method of laying the blocks are more important features than the size of the blocks, the character of the oil, or the method of treatment.

We are, of course, limited to certain kinds of timber, and are pretty well satisfied that a good, sound, southern yellow pine is about the best available timber, if it is in proper condition for treatment.

As to the method of laying, this is a matter which does not seem to have been given the amount of attention which it warrants. We are not justified in using or in laying the blocks in identically the same way under all conditions, and I have been particularly impressed with the results which can be accomplished where failures have occurred, with blocks which are identically the same as the ones that failed, by adapting the method of laying to the circumstances which have contributed to cause the failure.

Specifications for laying wood block pavement should give consideration to the relation between the width of pavement surface, the treatment of blocks, and the size and location of expansion joints. The width of joints between the blocks must also be considered. No one seems to wish to commit himself on this question of width of joints. Some specify tight joints and some open joints, but this is merely a relative description, which means little or nothing.

There exist today wood block pavements laid ten and more years ago, where the blocks were laid so close that they all touched one another and entirely without expansion joints, and yet many of these pavements have never bulged in the slightest degree. On the other hand, we have some new pavements, which seem to have been amply provided with expansion joints, and which have bulged badly. In every case, however, the old pavements which did not bulge were laid on streets where the local conditions for a pavement were of the best, while where considerable bulging was experienced, the local conditions generally were bad and were not properly provided for.

A wood block pavement is one of our highest types of modern, smooth, clean, noiseless, and durable pavements. The two faults pointed out should not detract from its use, but it is essential that the bleeding be eliminated by the proper treatment with preservative oils whose properties are such that they will not cause the block to bleed, and it is further essential that the blocks be so laid that they have the opportunity to expand without bulging, if they are not laid in a fully expanded state. Intelligent investigation and experimentation will, without doubt, in time overcome both of these difficulties.

---

* Presented at the Tenth Annual Convention of the American Road Builders' Association.

Asphalt Block Pavements

Asphalt block should not be used on heavy traffic streets, particularly where there is considerable steel tire traffic, as the life of the pavement is very short on such a street. On the other hand, they have given splendid results on automobile roads leading from the city into suburban districts.

The asphalt block pavement is particularly suited to villages or country districts not large enough to support an asphalt plant, as no plant is required for the first construction, nor for the maintenance.

Many asphalt blocks which have been manufactured in the past have been complete failures and have been the cause of creating a strong prejudice against this material. The specifications for asphalt blocks generally provide for: the size of the blocks; the composition of the blocks; the character of each ingredient; the specific gravity of the block and the method of laying.

The failure of asphalt block pavements is due to entirely different causes from the failure already described under the wood block pavements. We do not have the question of bleeding or expansion to deal with. The difficulties in this class of pavement have been to secure blocks which have been manufactured with proper ingredients, mixed in proportions which make them fit to withstand the wear and tear of traffic, and blocks which are properly moulded and compressed. The specific gravity has been considered as an index of these requirements. The size of the blocks and the method of laying are both, of course, of importance. It is essential that the blocks be of sufficient size to have stability, and that they be laid in such a way as to be held rigidly in place.

Asphalt blocks are composed of asphaltic cement, crushed trap rock, and mineral dust. Considerable difficulty has been experienced in producing a block which would answer the needs of traffic, and at the same time one which will not deteriorate rapidly under the climatic conditions to which it is subjected. The successful manufacturer of such a block undoubtedly requires a tough asphaltic cement, that is, one which will produce a block the edges of which will not "ravel" under traffic in winter, and secondly, a proper proportioning of such an asphaltic cement to the trap rock and mineral dust, so that the block will not elongate or "shove" under traffic in summer. In almost all cases where an asphalt block has failed, the failure has been due to disintegration, and the amount of asphaltic cement which the block contained was very small as compared with the amount of asphaltic cement in an ordinary sheet asphalt pavement.

A great advance has been made in the last few years in this direction, and blocks are now being manufactured which are standing up well under considerable traffic, and which at the same time contain sufficient asphalt, so that their lasting qualities will be greatly improved. Machines for moulding and compressing the blocks have also been improved, and without question some of the asphalt blocks which are now being manufactured measure up very favorably with other standard types of pavement.

The Economics of the Water Meter*

By John Ericson †

In 1950 Chicago will have a population of 5,150,000. The consumption of water per capita has increased from 43 gal. in 1863 to 203 gal. in 1912, or about 160 gal. in fifty years. If we assume the increase in the future at half the rate of the past, we will have in 1950 a per capita consumption of 263 gal. This will require a daily pumpage of 1,350,000,000 gallons, or, in other words, the present enormous system must be more than doubled in 38 years.

Nearly fifteen years ago the author commenced a series of careful investigations to determine the use and abuse of the water-supply of Chicago, and has since endeavored to point out the advisability of conservation and the restriction of the waste and leakage of our water-supply. The best and generally approved method for this purpose is the installation of water meters, a method that has proved economical and satisfactory in Europe and in those American cities where it has been adopted.

A statement showing the water meters installed during August and September, 1911, was prepared, and about a year later a careful comparison was made showing the effect on rates of the installation of these meters. They were 261 in number, of ⅝-in. to 8-in. size, and were set on all classes of service and in all parts of the city. They included saloons, foundries, railway stations, residences, laundries, buildings with hydraulic cellar drainers, hotels, factories, garages, milk depots, greenhouses, fish markets, office buildings, warehouses, apartment buildings, etc.

Where the difference was obtained, 124 premises showed an increase and 56 showed a decrease in the bills by the installation of meters. The total of the excess meter rates for six months amounts to $2,885. The total of decreases, by reason of setting meters, for a period of six months, amounts to $495, making a net increase of $2,390, or $4,780 as the annual compensation for the setting of these meters. These figures indicate that if the placing of meters is judiciously made, irrespective of a decrease in pumpage, the city's revenues will be increased rather than diminished.

In spite of the campaign for a restriction of leakage and waste, and in spite of the economy and satisfaction that water meters have given in other cities, so much opposition to this method is met with in Chicago that only about six per cent. of the service pipes have so far been metered.

Designs for municipal water meters have lately been perfected in the office of the city engineer, and sample meters made from these designs are now being tried. It is expected that, as soon as these meters have proved satisfactory on trial and have been adopted as standard the installation of meters on a much larger scale will be commenced.

One of the important reasons why Chicago has to pump such great quantities of water, and why there is always such urgent necessity to build additional tunnels and pumping stations, is the failure to adopt rational methods of water-waste prevention. An argument often heard is that we have an inexhaustible supply of water right at our doors and that the water should be as free and abundant as the air we breathe. If this excessive pumpage would benefit the people, there would be nothing to say about it. But, as a matter of fact, the wasted water does no one any good, and when escaping into the ground it often becomes a detriment rather than a benefit.

---

* Extract from a paper on "The Chicago Waterworks," in the Journal of the Western Society of Engineers.

† City Engineer, Chicago.

When it is considered that the cost for coal alone to pump the many million gallons of water in Chicago is now about $450,000 per year, it will be seen that by reducing the per capita consumption from 203 gal. to 120 gal. per day, which amount should be sufficient for any city, a saving from this item alone would amount to nearly $200,000 per year.

When we consider also the additional cost on the account of larger pipes required to carry the excessive quantities of water, other operating expenses, and the interest on cost of tunnels and pumping stations that could be delayed under proper restrictions, the saving per year would amount to many thousands of dollars more.

Concrete Tile Blocks Manufactured by Wet Process

CONCRETE tile blocks are being manufactured in a specially built factory in the Canal Zone, for use of the new Administration Building at Balboa. The process used is the invention of A. A. Pauley, who installed the manufacturing plant and who has granted the sole right for manufacture on the Isthmus of Panama to the United States.

The blocks are manufactured by a wet process quite different from the dry process generally used in making concrete blocks. Concrete is mixed in the plant in the proportion of one part of cement, one and one-half parts of sand, and two parts of stone screenings. It is mixed fairly wet. Each molding machine is capable of turning out four of the smaller blocks at a single operation, and three of the larger sized blocks, The forms are inclosed within a double cast-steel lining with a space between for the priming steam. In molding a block the first step is to insert at the bottom of the form a cast-iron frame having the shape of the solid portion of the required block. This acts as a base and support for the block. The valve from the concrete mixer is then opened and the concrete is allowed to flow down a short chute to the top of the mold. A workman then diverts the thin or wet concrete with a trowel into the crevices around the forms until all are filled level with the top. Steam, which may be graduated to the desired pressure by a series of valves located beneath the machine, is then turned on for a period of four minutes, at the end of which time the concrete has so stiffened that it will stand alone and is turned out of the mold by means of a crank, which pushes out the interior form. The blocks are then lifted from the mold and transferred to short lengths of wooden planking and placed on receiving racks, which are on a combined moving platform and elevator system, which carries the blocks to the curing room.

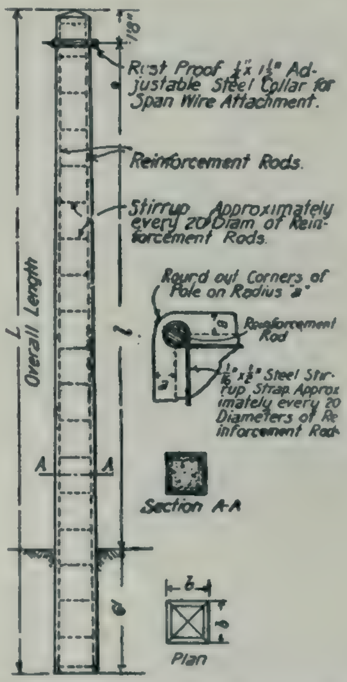
The curing room consists of 24 galvanized iron compartments, each about 45 ft. long, 4 ft. wide, and 8 ft. high, entirely inclosed. In these rooms the blocks are given their perfecting treatment, which consists of a combined steam and water dripping process, devised to facilitate the setting up and hardening of the blocks, so that within 48 hours they are ready to be removed to the storage yard.

Each unit of the plant is operated by individual electric motors. The steam is generated by two boilers located in a shed outside the plant.

Blocks to be made are 12 x 12 x 18 in., for foundations or walls, 8 x 12 x 12 in. for main walls, 8 x 8 x 16 in. for corners, 6 x 12 x 12 in. and 4 x 12 x 12 in. for partitions, and 3 x 12 x 12 in. for interior columns.

Suggested Design for Reinforced Concrete Poles

A suggested design for concrete poles was included as a part of the report of the committee on power distribution presented before the American Railway Engineering Association at the recent annual convention. The committee reported that not much information was available on the subject of reinforced concrete poles, and the design, which is shown in the drawing reproduced herewith, was presented only in a tentative way for experimental purposes. "An effort was made to have a simple design," the committee states, "and it is fully believed that that presented will meet the ordinary requirements for a trolley line. No doubt experience will determine a number of ways in which the pole may be improved." It is intended to serve the same purpose in trolley line construction as the wood or steel pole ordinarily used. This particular design has not been manufactured or tested in actual use, as yet.


1/8"
Rust Proof ¼" x 1½" Adjustable Steel Collar for Span Wire Attachment.
Reinforcement Rods.
Stirrup Approximately every 20 Diam of Reinforcement Rods.
Round out Corners of Pole on Radius "a"
Reinforcement Rod
1/16" x ½" Steel Stirrup Strap Approximately every 20 Diameters of Reinforcement Rod
a
L
Overall Length
A
A
Section A-A
l
d
b
Plan

Experimental design for reinforced concrete poles.

Specifications accompanied this section of the report, of which those parts pertinent to the design of the pole are as follows:—

"Poles may be manufactured in wooden or steel forms, cast in horizontal position, and will require great care in handling during erection. The area of reinforcing rods shall constitute practically 4 per cent. of the base area of the pole, and shall be made up of four reinforcing bars placed as shown in Fig. 1. The modulus of elasticity of the reinforcing steel shall be at least 30,000,000. The longitudinal reinforcements will require stirrups at intervals of from twenty to fifty diameters of the reinforcing rods. These stirrups may be ¼-in. rods, or 1/16-in. by ½-in. straps, and should be bound around the four rods with a few inches extension of the ends to insure anchorage. By using sufficiently heavy stirrups and giving a complete turn about each longitudinal rod, the reinforcement can be formed into a self-supporting frame that will require only an occasional wooden spacing block to hold it in position while concreting the blocks to be removed as the concreting progresses. The span wires may conveniently be fastened to the pole by an adjustable collar of steel, or an aluminium fixture may be embedded. If steel is used, it should be approximately ¼-in. by 1½-in., adjustable and rust-proof. Steel pin pole steps may be inserted, and gains for cross-arms may be moulded when pole is being manufactured, as desired. The pins used shall be rust-proof. The concrete shall be made of Portland cement, meeting the test requirements of the American Society of Mechanical Engineers, of clean, sharp sand, and crushed stone, which shall be clean and free from dust, and not more than ¾-in. in its largest dimension. Clean washed gravel of the same size may be used in place of stone. The mix shall be of a richness of at least 1 part cement, 2 parts sand, and 4 parts stone."

The Canada Cement Company's Great Plant at Pointe aux Trembles, Que.

THE accompanying illustration is reproduced from a photograph of one of the most extensive and best-equipped cement mills in the world—the new plant of the Canada Cement Company, Limited, at Pointe aux Trembles. It is hoped to publish a detailed description of the plant in a later issue of this journal, but we give the following particulars from Industrial Canada, to whom we are indebted for the illustration.

The establishment consists of a crusher building, a rock storage building, a building for drying raw materials, a mill for grinding raw materials, a kiln building, a storage house for clinker, a mill for grinding clinker, a storage house for gypsum and five cement storage buildings, capable of storing one and a half million barrels of cement, covering an area of forty acres. The materials are obtained from quarries situated alongside of the mill and consist principally of a rock known as "Cement Rock." Coal is received by boats and is unloaded by means of a bridge crane. A private railroad, known as the Pointe aux Trembles Terminal Railway, runs from the dock to the mills and has connections with the C. N. R. main line and with the Montreal Tramways Company. Shipments are made at the present time either by rail, trolley or boat. The daily output amounts to 12,000 barrels per day, or 48,000 sacks. In the manufacture of this cement approximately 200,000 tons of coal are needed yearly.

The Canada Cement Company's new mill at Pointe aux Trembles.

A New Ten-Storey Building at Regina

SKY-SCRAPERS in Regina—the capital city of Saskatchewan, are limited to a height of ten storeys. At the present time there is only one structure in the city that attains the maximum height, namely, McCallum, Hill & Company's building, recently completed. Originally it was the intention of the owners to build an eight-storey structure, but when

McCallum, Hill & Company's Building, Regina

the city council fixed a limit of ten storeys, the company decided to add two additional storeys.

The McCallum, Hill & Company's building is not only equipped on the most modern style, but is well lighted and of pleasing design. The ground dimensions are 75 feet by 120 feet 6 inches. On the exterior, stone is used entirely for a height of two storeys, when brick of a color similar to the stone is used for the next six storeys. The top two storeys are brick trimmed with stone. The appearance thus given is as though stone were used throughout. The cornice and flashings are of copper, while iron panels are used between the brick columns above the second floor. Ornamental cluster lights are used for lighting the sidewalk around the building, while at the top pilot lights have been installed.

The building is equipped with private water and light system. The steam is first used in the generators and then in the heating system. From the generators are operated the motors, which provide the light, work the elevators and pump water. The owners sell lighting power to tenants at the same rate charged by the city.

In the basement is arranged the boiler room, pump room, engine room and a billiard room and barber shop. Apart from the offices on the main floor, provision is made for a vestibule and a public hall leading to the elevators. The walls are of marble to a height of four feet, the remainder of the walls being given up to large windows. The offices adjoining are in full view of the public using the halls. The remainder of the building is given up entirely to office suites.

The building is fireproof throughout, the walls and ceilings being of tile construction. The floors of all corridors above the ground floor are of terrazzo. The floors of the corridor and lavatory on the ground floor are of marble mosaic in three colors, the body white, with a selected border in green and buff. The stair treads and landings are of Italian marble. The vestibule and corridor on the ground floor, and one side of the stairway, from the ground floor to the first floor, are of polished white Italian marble wainscotting, four feet in height, with eight-inch base and four-inch cap of green verde antique marble. Messrs. Storey & Van Egmond, Regina, were the architects, and Messrs. Wilson & Wilson, Regina, the contractors.

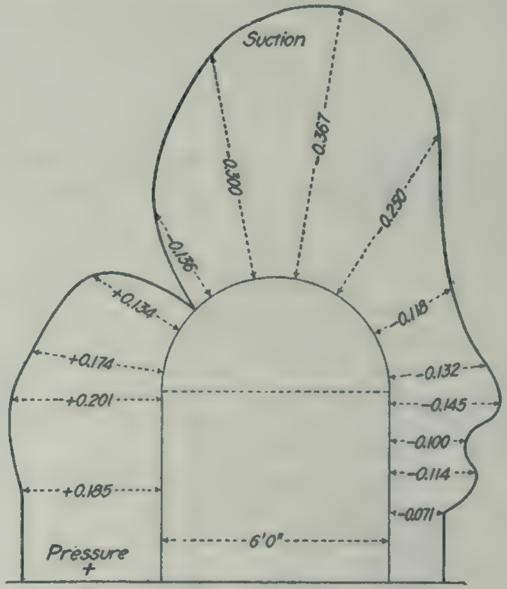
There is coming into use in Germany a cheap and ready method of asphalting a stone-paved street which is showing good results. The spaces between paving blocks are cleaned out to the depth of about an inch, and then a layer of melted asphalt is flowed over the street surface, the depth of the layer being about 1 in. Before it is cooled, sand is sprinkled on and the surface is smoothed. At Frankfort a section of this kind is now laid, and it appears to stand the wear remarkably well. Should the method prove a success in general practice, it will afford an excellent means of deadening the noise of city traffic at a small expense. It is quickly carried out, and it need not stop the circulation on narrow streets for any length of time. Moreover, repairs are easily made.

Fireproof wooden shingles are being made in the forest products laboratory of the University of Wisconsin at a cost of $15 per thousand. The method consists in forcing into the wood, under pressure, such chemicals as ammonia sulphate and ammonia phosphate.

Wind Load on Buildings*

EXPERIMENTS on a roof of semicircular section of 6-ft. span and 10-ft. length, covered with tin, mounted on walls 5 ft. high indicate that the common assumptions in regard to wind load do not come very near actual conditions. Results of the experiments led the author to propose a conventional loading of the full-wind specification over 90 deg. of the roof.

After each set of observations the roof was lifted and 6 inches of the walls were taken off. At the middle section of the building ½-in. holes were bored about one foot apart in walls and roof, the row extending from ground to ground. In the roof the holes had a short nozzle soldered on the inside. Tubes of rubber and glass led to a pressure-registering instrument consisting of a series of inclined glass tubes, one end of which was connected to a small reservoir and the other end to the tube from the holes. The gauge tubes were mounted in a frame, one over the other, with a scale in the centre. Photographs were taken of the meniscus to obtain simultaneous readings on all the gauges and at the same time that wind velocity observations were made, 30 ft. to the windward side with a Pilot tube, which had been calibrated with a thin plate. Kerosene was used in the glass tubes and reservoirs. The reservoirs were placed in sloping rows on the back of the frame so that when the whole instrument was tilted ¼ in. in 10 in. a horizontal plane passed through the centre of any tube at the middle would also pass through the middle of the walls of the reservoir of that tube.



Wind Pressure on Model House.
Figures in lbs. per square ft. Wind blowing from left to right.

The point of reversal of wind load from pressure to suction varied from 25 to 50 deg., but the average of seventeen readings indicate the point is at 45 deg.

In applying the unit loads it was proposed to draw on the cross-section of the building a semicircle with the half span as radius, placing the centre of this semicircle at such distance below the peak that the area of the cross-section of the building above the base of the semicircle is the same as that of the semicircle. The 45-deg. radii will then intersect the roof at the point of change in the loading units.

---

*Abstract of Paper by Prof. Albert Smith, of Purdue University, presented before the Western Society of Engineers.

Unique Features of New Toronto Theatre

THE most recent addition to Toronto's theatres is the new building which was opened for public entertainment a few weeks ago by the Loew Theatre Company of Canada. The construction of the building is unique in the respect that it contains two theatres, one above the other, so arranged that both can be occupied simultaneously. The main entrance is on Yonge street and the buildings extend back to Victoria street. The Yonge street building is two storeys in height, having a frontage of 38 feet, half of which is occupied to a depth of 100 feet by the main entrance lobby and also by a store which it is the intention to rent as a restaurant or tea-room. The front on Yonge street is composed of white marble columns, with Canadian granite base. The space above the first storey is entirely of terra cotta, and as a finish to the pattern panels in the brickwork on the Victoria street side terra cotta is also used at the corners. The style of architecture is modern and in this respect is uniform with all the theatres controlled by the Loew Theatre Company.

The building is of brick and steel construction, and the floors, balconies and roofs are of reinforced concrete. In the construction, yellow pressed brick and panelled brickwork was used. The coping is constructed of ornamental corbelling, giving the building an artistic appearance.

The lower theatre is 160 ft. by 100 ft. and the lobby 37 ft. by 160 ft. The lower theatre, including the balcony, has a seating capacity of about 2,300, that of the upper theatre being about 1,600. There are seven tiers of dressing rooms, laid out on the principal of three to each tier. Each theatre possesses its own separate stage, balcony and other fixtures and equipment, and such is the unique arrangement of both the theatres that a performance can be given on the lower stage and immediately transferred to the upper stage by means of a large freight elevator, staircase, etc.

Between each auditorium floor and the balconies, toilettes have been provided. The basement in the rear of the auditorium is utilized as a smoking room and lavatory. In the basement around the entire exterior of the auditorium is a pipe tunnel, five feet wide, which contains all the heating and plumbing pipes, at the same time serving as ducts for the passage of heated fresh air through mushroom heads into the floor of the main auditorium. The exhaust from the heated air is located in the centre of the main ceiling, thus affording a suitable outlet beneath the floor of the roof garden in the west wall.

The lobby in the Yonge street section is fireproof tunnelled, with brick walls on either side and concrete floors and reinforced concrete arches above.

The interior of the building is executed in a manner after the style of most theatres. The ceilings and cornice are finished in a handsome design of ornamental plaster. Similar treatment is applied to the staircases and elevator halls at the rear of the main lobby before entering the auditorium. The main lobby itself is finished in a colonnade of artificial marble or scagliola, tiled floors, bases, etc., the ceilings being very effectively treated in ornamental plaster.

An innovation is the provision of a roof garden. Entrance to the garden is provided by two elevators leading from the main staircase lobby and provision is made for a third elevator if required. A pleasing outdoor aspect is given to the garden by the display of artificial tree and foliage effects.

The important problem of exit facilities has received careful attention at the hands of the owners, with the result that the provision made in this respect is sufficient to ensure absolute safety. Around the main theatre at the west and north ends are the exit courts leading to Victoria street. Exits and all fire escape stairways are located in recessed fire towers with only the balconies leading from the exits to these fire towers intercepting the building line. Separate towers to serve each of the two houses have been located on each side of the building, while all means of exit are independent for both theatres.

The architects were Mr. Thos. W. Lamb, New York, and Stanley Makepiece, Toronto (associate). The general contractors are Fleischmann Bros. Company, of New York and Toronto. The firms who supplied the various structural materials are:—facing brick, Carter, Black, Ayres Company, New York; common brick, Don Valley Brick Works; steel, Canada Foundry Company, Toronto; reinforced concrete, White Fireproofing Construction Company, Montreal; elevators, Otis-Fensom Elevator Company, Limited, Toronto; Kewannee boilers and heating, John Ritchie Heating Company, Toronto; marble, Lantz Donban Company, Toronto; interior plastering, Cathcart & Kissel, New York; interior firing and lathing, Clarence W. Noble, Toronto; plumbing, A. Walsh & Son, Toronto; electric wiring, L. K. Cumstock Company, Montreal; granite, MacIntosh Granite Company, Toronto.

Millions for Harbor Improvements

The extensive harbor improvements undertaken by the government in all parts of the country will cost, when completed, something like $75,000,000. Every port of any importance now has under way works calculated to increase vastly the transportation facilities of the country from Halifax, N.S., to Victoria, B.C. St. John has the Courtenay Bay improvements and the dry dock, Quebec has large docks and dredging contracts, while at Levis what is said to be the biggest drydock in the world is under construction. The St. Lawrence channel is being deepened to Montreal while the port improvement scheme, when completed, will have cost eighteen million dollars. Toronto's harbor works will entail an outlay of another ten millions. At Hamilton, Sault Ste. Marie, Port Arthur and Fort William, similar undertakings will be advanced, while Winnipeg is getting navigation by the Red River. The Vancouver docks will cost upwards of $6,000,000, while in addition to the Victoria harbor works the site is selected for a drydock to duplicate that at Quebec.

Making Asphalt Pavements Non-Slippery

The Superintendent of Street Repairs of San Francisco has hit upon a method of removing the chief objection to asphalt pavement, described in the "Municipal Record," as follows:

The method of rendering the pavement less slippery is by heating the surface of the asphalt and then applying a layer of coarse sand which is rolled into the pavement, which affords a sufficiently rough surface to enable horses to keep their footing and automobiles to pursue a straight course in wet weather. Experiments with this pavement on Fell street, between Baker and Scott, and on Scott street, between Fell and Waller, have proved so satisfactory that the city officials have decided to extend its use to other parts of the city.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

For the past year the building permits of Outremont, P.Q., totalled $1,902,000, an increase of $319,500. The value of the permits issued in Westmount, P.Q., was $2,009,544.

The Highway Commissioners for Ontario will shortly submit their report to the government and legislature to enable the ministers to outline a general improvement scheme for the province.

A new building to be known as the House of Refuge (40 ft. x 100 ft., solid brick, two and a-half storeys high) will be erected during the present year in Algoma, Ont. It will accommodate fifty inmates. The architect is Mr. Thos. R. Wilks, of Sault Ste. Marie, Ont.

The Provincial Waterways Commission, presided over by Hon. S. N. Parent, have completed their report which is now before the government for consideration. It is thought likely that the commission will recommend the harnessing of the River St. Maurice near La Tuque, Que., by the building of a large concrete dam to develop over 500,000 h.p. for industrial purposes.

Arrangements for the publication of reports on the civic survey now being conducted by private enterprise in the several departments of the City Hall, Toronto, were announced recently at a meeting of the Citizens' Committee which inaugurated the scheme. It is the intention to establish in Toronto a permanent bureau in municipal research whose object will be to co-operate with the city council or prominent civic officials.

Mr. R. C. Harris, Works Commissioner, has issued his report on the necessary additions and extensions of the Toronto waterworks pumping and distributing plant. A total expenditure of $6,677,000 is recommended, as against $5,320,000 estimated by the special commission which reported to the city in favor of a duplicate system at Scarboro. Mr. Harris has thus disregarded the plans drawn up by the experts and their suggestion in favor of an expenditure of $1,071,000, on the ground that the present Rosehill reservoir with its 39,000,000 gallons capacity, is sufficient. A filtration system, however, would be constructed in connection with the pumping station at Victoria Park.

A report from Ottawa states that Mr. Sanford Evans, ex-Mayor of Winnipeg, will head the Commission which the government proposes to appoint to consider the economic feasibility of the Georgian Bay canal proposition. The Commission will consist of three men, one from the west, one from Montreal, and the other from Ontario. Mr. Huntly Drummond, of Montreal, has been favored by many as the Quebec representative, but a French-speaking man may be selected. Some years ago a complete survey for the projected work was made and the cost was estimated at $100,000,000. There has since been a revision of the estimate and the figure is now placed around $125,000,000. Reports made so far establish beyond question the practicability of the canal as an engineering work.

T. McAvity & Sons, Limited, St. John, N.B., will call for tenders early this year for the erection of the largest part of a great plant on a site comprising twenty-two acres located beyond the Marsh Bridge. Here the firm propose to assemble their whole iron and brass manufacturing plant, and afterwards enlarge their operations until there will be a group of sixteen different buildings, and an industry affording employment to between twelve and fifteen hundred people. The contract for the whole sixteen buildings will not be awarded this year, but it is proposed to erect a very large part of the entire plant within the next two years, beginning in the present year. A spur will connect the plant with the Intercolonial Railway, and the St. John Valley Railway and Grand Trunk Pacific will also be connected when they come in to their St. John terminals at Courtenay Bay.

Advices from St. John, N.B., state that the establishment of large industries and the extension of the street railway line will result in extensive building operations in that city. It is practically certain that one or more companies will undertake the erection of groups of buildings for residential purposes, being thereby able to carry on the work of construction at less cost than in the case of small contracts. The value of building permits last year was over $2,380,000, which was an increase of about 320 per cent. over the value for 1912. The present year may not show as great an amount, because last year's contracts included a sugar refinery, grain elevator and other large ones, but the number of individual buildings to be erected this year will be much larger than that of last year. The present indications are that while some industrial establishments will be built or enlarged, the greatest amount of attention will be devoted to providing homes, for which the demand exceeds the supply and grows greater month by month.

WESTERN CANADA

Pending the reorganization of the office the city building inspector's department of Calgary has temporarily suspended the issuance of building permits.

Mr. J. P. Jones, Dominion Government Commissioner, and Mr. Hough, Engineer, recently inspected the site for the new terminal elevator on the government land at Calgary. This section is on the main line of the C. P. R., and can easily be served by spur tracks of the C. N. R. and the Grand Trunk Pacific.

Medicine Hat erected and placed in operation ten new factories last year. These include the Medicine Hat Pottery Company's plant, the only concern of its kind in western Canada. Several hundred thousand dollars have already been spent by the Canada Cement Company on the site of their four thousand-barrel mill, a few miles west of Medicine Hat. The total expenditure in buildings for that city is expected to exceed $2,500,000.

Official announcement is made by Hon. Robert Rogers, Minister of Public Works, Ottawa, that the government has decided to purchase the Bullen site on Lang Cove, Esquimalt, for the construction of a new $4,000,000 dry dock, capable of handling the largest ocean liner afloat. Mr. Rogers has already given orders to prepare the plans for the undertaking, and the engineers of the department are already at work on them. The new dry dock will be 1,150 feet long, and have a 12-foot clear entrance with a 40 feet depth on the sill at ordinary high water, and 50 feet depth at the approach.

The building permits issued at Vancouver during December amounted in value to $175,245, and $10,424,447 for the year 1913. The total for December, 1912, was $1,530,365, and for the year $19,438,432. 286 permits were issued during the year for office buildings and stores of a value of $5,236,371; 162 permits for factories and warehouses, valued at $2,027,278; 62 permits for apartment and rooming-houses, valued at $1,328,834; 1,302 for dwelling-houses, costing $1,687,447 and 215 for repairs and alterations, costing $104,927.

Tenders have just been taken for the construction of an arts building for the University of Alberta, Edmonton, to cost about $500,000. The building in plan will be 300 feet long by 70 feet wide, with an auditorium wing from the rear 60 feet wide and 93 ft. 4 in. deep, and will be three storeys high above the basement, with an attic storey for draughting rooms. The construction throughout will be first-class, though the building will not be entirely fireproof. The exterior will be dark red tapestry brick, with Indiana limestone trimmings. The superstructure will be partly of steel, with reinforced concrete floors in the main corridors and other public gathering points, and timber floors elsewhere. All partitions are to be of Medicine Hat terra cotta blocks.

Mr. A. W. Ellison Fawkes, water engineer, reports that the construction of a gravity pipe line to the mountains on the Elbow River together with a storage dam for the future water supply of Calgary would be the cheapest in the end. Four different estimates on the cost of constructing gravity lines to four different sites for storage dams were supplied as follows:—For the thirty-nine mile line, $2,158,673; for the thirty-eight mile line, $2,128,763; for the thirty-six mile line, $1,977,322, and for the thirty-two mile line, $1,718,343. The alternative scheme of pumping water from the Bow River, with a big filtration plant, was estimated by Mr. Fawkes to cost $1,119,835 for the forty million gallons supplied and $807,657 for twenty million gallons supplied. The city council is expected to spend several weeks studying the report before definite action is taken on the subject. Mr. Fawkes, who favors the gravity system, has the concurrence of Mr. G. W. Craig, formerly City Engineer of Omaha, Newbraska.

Montreal's Intake Conduit

The Montreal Council have voted $100,000 for connecting the water conduit to the Lachine Canal, in order to obtain an emergency supply. A further like sum may be taken from the reserve fund for repairing the break in the conduit which caused the greater portion of the inhabitants to be without a regular supply for about a week. Orders have been placed for the necessary pipes to make the connection with the Lachine Canal. These will be of steel, eight feet in diameter, and 1,500 feet in length. Meanwhile the conduit is being strengthened for a considerable distance from where the break occurred, it having been decided to erect timber cribwork and fill with 5,000 cubic yards of rock, hauled by means of a temporary railway track. Mr. Freeman, the New York expert, commissioned by a body of citizens, has made one report, and Messrs. J. A. Jamieson, R. S. Lea and G. R. Heckel, the experts employed by the city, have also made an interim report, which will be followed later by an exhaustive report on the whole situation. Representatives of the principal commercial associations, including the Builders' Exchange, have asked the mayor, for an independent commission of inquiry, composed of a judge of the Superior Court and two engineers of the highest standing, to investigate the break in the conduit and apportion the blame, the water department, and the scheme of water supply. The commission should be free from civic influences. The mayor has promised that an enquiry shall be held in due course, but the Board of Control will have to decide on the method.

Personal Mention

The will of the late Mr. Richard Chalkley, contractor, who died in Toronto, December 27, 1913, has been filed for probate. The estate is valued at $80,924.

Mr. W. H. Palmer has been elected President of the Chatham Builders' Exchange. The meeting has made a recommendation in favor of the appointment of a City Building Inspector.

Messrs. J. A. Jamieson, R. S. Lea and G. R. Heckle have been retained by the Board of Commissioners of Montreal to make a report as to the cause of the recent failure of the intake conduit.

Mr. Chas. A. Millar, manager of Price's Limited, and president of the Canadian National Clay Products Association, is leaving shortly for the south where he will attend a number of United States clay-working conventions.

Mr. W. A. McLean, Provincial Engineer of Highways for Ontario, and vice-president of the Ontario Highways Commission, returned last week from Nova Scotia where he had been devoting some time to an investigation of highway conditions.

Mr. John R. Freeman, of New York, has prepared a report on the failure of the intake conduit at Montreal. The report was made at the instance of private interests who, it is understood, are endeavoring to influence important recommendations.

Mr. E. E. Brydone-Jack, M. Can. Soc. C. E., Professor of Civil Engineering in the University of Manitoba, was presented with a clock at Winnipeg on January 9 by the Manitoba Branch of the Canadian Society of Civil Engineers in recognition of his services to the Society.

Sir Percy Girouard has been elected president of the Armstrong-Whitworth of Canada, Limited, the new steel company which is constructing a big plant at Longueuil, P.Q. The other directors are: Sir George Herbert Murray, P.C., C.B., Saxton William Armstrong Noble, George Green Foster, K.C., and Matthew Joseph Butler, C.M.G.

Mr. H. G. Fulford, of Galt, Ont., and Mr. J. Evans, of Berlin, Ont., have formed a partnership as architects and their headquarters will be the former office of Mr. Evans in the Scott & Bennett block, Water Street, Galt. Mr. Fulford is a member of the Ontario Association of Architects and also of the Royal Canadian Institute. Formerly he resided in Toronto.

Mr. Carl M. Starkey, chief engineer of the H. E. Talbott Company, engineers and contractors of Dayton, Ohio, died in Montreal, of typhoid fever. He had been engaged in work at Grand Mere, Que., on the 180,000 h.p. hydro-electric power plant which the H. E. Talbott Company is constructing at that place for the Laurentide Company. Mr. Starkey had been previously engaged on the Panama Canal work.

Mr. Neil Gillies has been appointed Toronto Manager of the Master Builders Company, Toronto. Mr. Gillies first came to Toronto as manager of the Toronto business of Canada Floors, Limited. Later he formed a partnership under the firm name of Brett, Gillies and Moyes of Montreal and Toronto, carrying on an extensive business in composition and asphalt flooring. Through this connection Mr. Gillies is well-known among architects and contractors, and his appointment will enable the General Sales Manager, Mr. A. D. Dame, to devote more time to the supervision of the company's organization throughout the rest of Canada. This includes branch offices at Montreal and Winnipeg, as well as agencies in all important cities from coast to coast. We understand that Mr. Dame expects to leave for the Pacific coast in the near future.

Canadian Railroad Development

At the semi-annual meeting of the Grand Trunk Railway Company in London, Eng., Mr. A. W. Smithers, chairman of the board of directors, predicted that the last two hundred and thirty miles of road in western Canada would be completed by June next year.

Mr. Joseph Gosselin, contractor for the building of the Transcontinental Railway workshops at St. Malo, Que., is stated to be making arrangements for the employment of 1,000 men on the work. Operations will be continued actively from now until the contract is completed.

The North Railway Company have applied to the Federal Government for a subsidy for constructing the line to James Bay, a distance of 550 miles, joining up Montreal to the Transcontinental. The Government have already guaranteed the bond issue, and the company now ask for a subsidy in addition.

Plans are maturing for double-tracking the C. P. R. between Toronto and Windsor, and it is announced that the new steel will be laid as far as London before work is stopped in the fall. It is stated that important schemes for the development of Sarnia are under consideration and that options on large tracts of land have been secured.

It is expected that during the present year operations will begin on the construction of a railway across the northern part of the State of Maine connecting the existing lines at Quebec and New Brunswick, and over New Brunswick, to the Quebec border, the part for which the charter has been obtained being a distance of about 111 miles. This is likely to be an electrical road according to a statement made recently by Mr. A. R. Gould, president of the St. John Valley Railway Company.

Indicative of the fact that the Pacific Great Eastern railway intends to start a regular service north of Newport, B.C., at an early date was the announcement made on January 2 by Mr. A. H. Sperry, general manager, that an order has just been placed for 150 steel freight cars, which are to be delivered at Newport during March, April and May, 1914. The rolling stock is to be supplied by the National Steel corporation of Hamilton, Ont. Steel rails sufficient to lay 30 miles of track are now at Newport for the Pacific Great Eastern. Track has been laid 13 miles north of Newport and grading has been finished more than 150 miles from the Pacific terminals, being well advanced beyond Lillooet.

The Canadian Pacific Railway has a big programme ready for construction work in 1914, according to a despatch from Ottawa. Some of the work was started in 1913, but only the preliminaries were attended to. Among the more important works are the following: double-tracking between Sudbury and Port Arthur, between Port Arthur, Calgary and Vancouver, between Brandon and Calgary, the double track through Rogers Pass tunnel, double-tracking between Revelstoke and Vancouver, a 290-mile line between Sedgewick and Edmonton, two lines from Bassano to a connection with Swift Current. In addition to these, there are many small lines and extensions throughout the west, all of which, it is said, will cost more than $100,000,000.

A deputation representing the North Railway Company, waited on the Government on January 8 and asked for a bond guarantee of $35,000 per mile on the line the company is planning between the National Transcontinental Railway and the city of Montreal. Renewal of a subsidy formerly voted by Parliament for the construction of a road between Montreal and James Bay was also requested by the delegation which was received by Rt. Hon. Mr. Borden and Cabinet members. A bond guarantee of $35,000 per mile was asked, together with subsidies of $6,400 per mile for the line already constructed. The company has been given land grants by the Quebec Government of about 8,000 acres per mile and 10,000 acres per mile on the proposed Montreal Transcontinental and Montreal-James Bay lines respectively. In presenting its case the delegation urged that the North Railway was in every sense a road of a national character, and therefore entitled to Government assistance. Besides connecting Montreal directly with the Transcontinental line, it will provide an alternative grain route to that of Hudson Bay by affording transportation facilities from the Nottaway River.

Convention Notes

The Toronto Branch of the Canadian Society of Civil Engineers holds its annual meeting to-day (January 21) at 8 p.m. at the headquarters of the Engineers' Club of Toronto.

The annual meeting of the American Society of Heating and Ventilating engineers opens to-day (January 21) in New York and closes on January 23. The Secretary is Mr. E. A. Scott, 29 West 39th street, New York City.

The fifth annual meeting of the American Society of Engineering Contractors was held on January 16 in the United Engineering Building, New York City. One of the features of the evening session was a lantern address on road construction given by Mr. Geo. C. Warren, president of Warren Brothers Company, Boston, Mass.

Cement users are reminded of the big events scheduled to be held in Chicago next month. The National Conference on Concrete Road-Building opens on the 12th and closes on the 14th and the American Concrete Institute is in session from February 16 to February 20. The Secretary of the Conference is Mr. J. P. Beck, 72 West Adams Street, Chicago, and the Secretary of the Institute is Mr. E. E. Krauss, Harrison Building, Philadelphia.

Mr. Jas. E. Wilson is leaving the Sewer Department of the city of Calgary to engage in the contracting business.

The Des Moines Bridge & Iron Company, of Pittsburgh, Pa., and Des Moines, Ia., have opened a contracting office at 50 Church Street, New York City, of which Mr. J. E. O'Leary, one of the company's contracting engineers, is in charge. This office will handle the business in the coast states north of Virginia and in Eastern Canada. The Des Moines Bridge & Iron Company makes a specialty of the design and construction of hemispherical bottom steel tanks on steel towers for municipal, railway and industrial work.

Obituary

Mr. George Wilson, for many years a member of the building and contracting trade, died at St. Thomas, Ont., on January 14, after a brief illness. The late Mr. Wilson, who was 60 years of age, was a native of Windham, Ont., and bore the reputation of being one of the most reliable men in the business.

Mr. George Gordon Miles, a well-known Toronto builder and contractor, died on January 12 from heart failure, said to have been brought on by excitement owing to an outbreak of fire in the vicinity of his factory in West Toronto. The late Mr. Miles, who lived at 24 Rusholme Road, was a native of Scotland where he was born in 1849. His name is connected with many of the prominent buildings erected in Toronto during the past few years, including the new wing of the western hospital, the woodwork of which he constructed, and also the new section of the Robert Simpson Company's store.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **January 28, 1914** **No. 4**

Principal Contents

Page
Is Competitive Bidding a "Lottery"? 93
Vulgarity and Obtrusiveness in a New School of Design. 93
Increased Efficiency of Hydraulic Turbines 94
Toronto's Civic Survey Report 95
Canadian National Clay Products Association 95
"English as She is Writ" 95
Engineering Topics in the Old Land 96
Bush-Hammering to Relieve Concrete Surfaces 97
The Beautifying of Highway Bridges 98-104
By H. G. Tyrrell
Replacing a Three-Span Cantilever Bridge by an Independent Span 104
Substructure Work for the Canadian Pacific Railway Bridge at Mud Lake, Ont. 105
Use and Cost of Concrete Pedestal Piles 106
Prevention of Dampness in Buildings 107-110
By Geo. Melson, F.R.I.B.A.
The Qualities of Sheet Asphalt 111
Regina Correspondence 112
Letters to the Editor 113-117
Discussion of the editorial article, "Engineering Responsibilities and Lay Administration" (Contract Record, January 14, 1914).
Correct and Incorrect Methods of Factory Lighting ... 118
By G. H. Stickney
Ontario Reunion of McGill Science Graduates 119
An Amendment to the Saskatchewan Public Health Act. 120
Engineering Progress at Nanaimo, B.C. 120
Constructional News 122-124

Is Competitive Bidding a "Lottery"?

ONE of our contracting friends on the other side of the border, who espouses the cause of having quantities furnished to contractors by proper quantity surveyors, humorously suggests that in order to further the end in view, the owners might, as a beginning, be indicted for running a "lottery," which they do when they invite bids on building work, figuring having become so largely a game of chance under existing methods. We must admit that this viewpoint had not presented itself to us before, although we had recognized many defects in the prevailing system. There is certainly room for improvement in methods of estimating and we believe that the introduction of the quantity system would open up a wide avenue of improvement. The idea of the quantity surveyor is certainly gaining in favor in the United States, thanks largely to the efforts put forth by the American Institute of Quantity Surveyors.

At Spokane, Wash., at a meeting of architects and contractors held to consider estimating methods, one of the audience expressed the opinion that Shylock of old was originally a building owner, who had tried, first of all, to get his full pound of flesh out of some contractor, and that the account of him handed down to us in the "Merchant of Venice" was a distorted one. History had repeated itself, for in these days there were owners who would squeeze contractors whenever they got the chance and who preferred not to state frankly and honestly upon how much material they wished bidders to estimate. The speaker contended that the quantity system provided the remedy.

The quantity system of estimating consists in furnishing to each bidder an itemized, detailed copy of all the quantities of materials and labor necessary to construct a building. Against each item each bidder places a unit price, including such profit as he may wish to make. All items are then figured out in dollars and cents and totalled, the result being the amount of the bid.

Vulgarity and Obtrusiveness in a New School of Design

THERE are many ways in which we can emulate the United States to considerable advantage, but architectural practice, generally speaking, is not one of them. We make the point because—for a time, at any rate—the interest of the man in the street has been centred in the so-called "skyscrapers," the latest abomination to which we have been reduced by overcrowding in our cities and encouraging speculators to "boost" the value of restricted areas of property. Our municipal authorities have shown evidence of some enlightenment in this regard of late, but the fact remains that here in Canada it seems preferable to boast that we have the highest building in the British Empire to priding ourselves that we have one which is in the first rank of those famed for the excellence of their design and for the manner in which they exemplify the best principles of sanitation, lighting, heating and ventilating.

The city of Toronto is going wild in its advertisement of the transformation that will be effected at the corner of King and Yonge streets upon the completion of the buildings now in course of construction. But after all, these structures serve but to emphasize the fact that such is the greed of the age that we are ready to build upon the mistakes of others and to perpetrate fresh mistakes if the financial inducement be of sufficient consideration. Who that has visited Toronto has not had thrust upon him the fearfully congested state of various down-town intersections at busy hours—a constant and growing reminder of the lack of foresight in laying out the city's main thoroughfares. We regard ourselves as a nation of builders and take a pride in the constructional development of our country, but we must see to it that we keep well abreast of really sound principles of design. It is a sign of the times, and one which should provide us with food for a little reflection, that the Japanese are beginning to deride the architectural attainments of the country to the south of us, characterizing them as mere accumulation of building material, possessing no artistic value at all.

"Mere accumulation of building material" may serve the immediate end of enriching the present generation, but it will not provide an inspiration for the next. Unless we strive for artistic creation we shall never rise above the commonplace. Arguments against giving art its proper place in building design proceed only from ignorance. A country without art is like a man without a soul, and there is all too little evidence of art in Canada. Let us hope that the twenty-two storey building upon which operations are just commencing in Toronto will remain the tallest building in the British Empire until the end of our day and generation. These towering structures may have merits in their own "school," and along general lines of design they may survive careful analysis; but the fundamental principles of the skyscraper are vulgarity and obtrusiveness.

Increased Efficiency of Hydraulic Turbines

DEVELOPMENTS in the design of hydraulic turbines during the last ten years were featured in an interesting paper entitled, "Present Practice in the Design and Construction of Hydraulic Turbines," presented by Mr. Birchard Taylor at a meeting of the Mechanical Section of the Canadian Society of Civil Engineers on January 15. The meeting was presided over by Mr. H. H. Vaughan and an interesting discussion followed the reading of the paper. Mr. Taylor observes that hydraulic turbine design has passed through a stage of wonderful development during the last decade, and, in respect to many features, remarkable progress has been made toward bringing the turbine to a higher state of perfection.

As a result of theoretical investigation, substantiated by experimental research of the highest order, efficiencies have been increased on the average about ten per cent. Corrosion of runner vanes, at one time a serious factor as affecting the maintenance of turbines and their efficiencies, has been eliminated subsequent to conclusive demonstration that it is primarily the result of defective design. The development of high specific speed runners, thereby permitting the use of higher rotational speeds, has resulted in the rapid passing away during the past few years of the multi-runner types of turbines in favor of the vertical shaft, single runner type. At one time it was generally thought that the character of speed regulation of a turbine was dependent entirely upon the governor. Today, however, it is known that the make or type of governor has little or nothing to do with speed regulation, except in so far as it must have sufficient power and proper adjustments to move the turbine gates in a certain time and without hunting.

Ten years ago it was considered a notable achievement to obtain in a turbine in place an efficiency as high as 82 per cent. The average of the best results secured was in the neighborhood of 80 per cent. The maximum guarantee of the builders were from 78 to 80 per cent., and were considered highly satisfactory. During the past two years, efficiencies between 89 and 92 per cent. have been quite common, while a maximum value of 93.7 per cent. has been secured. Today the builder must guarantee an efficiency of at least 87 per cent. in order to secure business.

It is interesting to note that the improvement in turbine efficiency has taken place during the time when the general policy of the power companies toward the builders has changed from one under which a great majority of contracts were awarded to the lowest bidder to the present one under which merit is frequently given first consideration. Under the former policy, business was secured by the builders at such prices as to allow little or no margin between actual cost and selling price. As a majority of turbine installations undertaken ten years ago were unsuccessful at the start, and required alterations or replacements to make them acceptable, the contracts which showed a profit were few and far between. Thus there were frequently no funds available to cover the cost of experimental work by the builder to improve the quality of his product. As the data available ten years ago was by no means reliable, a majority of the builders had very little assurance of the successful outcome of their work. There was, consequently, a very strong incentive on the part of some of the builders to avoid, if possible, the making of any tests which might prove that the apparatus had failed to meet the guarantees. Most of the important contracts are now awarded on a basis of merit, and designs and guarantees are given far more consideration than price. A great amount of work is done on a cost and percentage basis, whereby the builder is guaranteed a profit, contingent on the proper execution of his part of the agreement. The ability of the builder to construct the apparatus in accordance with his designs is now taken into consideration in comparing competitive designs.

A high guarantee of efficiency is no longer satisfactory to the purchaser unless it can be justified by conclusive evidence in the form of reliable data secured from tests on similar apparatus, or in connection with experimental turbines tested by disinterested parties. The builder who, by the presentation of such data, demonstrates that his guarantees will probably be exceeded, is given preference over his competitor who, although he may have made the same guarantee, is unable to prove that he has an equal margin in reserve.

Engineers of power companies are now taking a much greater interest in the experimental work of the builders than previously, frequently volunteering to share in the expense; provided, of course, that such work will be of some aid to them in selecting the best type of apparatus. In some instances, power companies have allowed under contracts certain sums of money to be expended on experimental work to be carried out by the builder. In many contracts for waterwheels placed during the last few years the builders have been required to guarantee the efficiency on a bonus and penalty basis, the rate ranging anywhere from $1,000 to $5,000 per unit for each one per cent. of efficiency, the rate in each particular case depending, of course, upon the value of efficiency to the purchaser. This co-operation on the part of the power companies has been a very important factor in producing the remarkable improvement in efficiency which has been obtained during the past ten years, for it has made possible the expenditure of considerable sums of money to cover the costs of research and experimentation. Another important factor in the rapid strides made in waterwheel design during the past ten years has been the co-operation on the part of consulting hydraulic engineers.

Report of the Civic Survey on the Toronto Works Department

THE Civic Survey Report on the Toronto Works Department has been issued to the public by Mr. Winfred B. Holton, of the New York Bureau of Municipal Research. The entire report comprises about 32,000 words and the portion issued was merely a summary or general statement.

It is pointed out that the survey was undertaken at a time when the entire organization was undergoing many changes. The present administration of the Works Department is highly commended for its initiative and resourcefulness in dealing with reorganization problems.

Summarized, the recommendations are as follows:

(1) Centralization of working forces as an essential to efficient management, specifically by (a) central stenographic division, (b) central permit division, (c) central drafting and surveying force, (d) central inspection force, (e) central payroll division, (f) return to former method of operating street cleaning and garbage collection as section of Department of Works; (2) reduction of stores force; (3) care in seeing that each class of employees is kept to its own kind of work; (4) change of methods of appropriation control by new accounting procedure and administrative practice; (5) revision of contract accounting; (6) installation of adequate system for keeping cost and expense records; (7) establishment of repair fund for outside work; (8) standardization of permit forms; (9) revision of forms and methods in street opening permits; (10) new stores ledgers and periodic audit; (11) introduction of adequate time and service records; (12) revision of report forms; (13) improvement of form and prompt publication of annual report; (14) establishment of general ledger control of subsidiary accounts; (15) provision for prompt payment of department bills; (16) consolidation of Departmental Reference Library with Municipal Reference Library; (17) adoption of plan by which street-cleaning force will make light street repairs; (18) study of relative efficiency of large and small sewer catch basins, with reference to cost of cleaning; (19) greater co-operation between roadway section and street-cleaning department; (20) adoption of definite programme for sidewalk improvement; (21) more intelligent diversion of traffic from streets closed for repairs; (22) citizen backing of Works Department in programme to rid the city of overhead wiring; (23) advisability of department's doing all its own teaming work; (24) sending of notice to property owners affected when street is to be torn up by construction work; (25) putting construction and maintenance of park roads under jurisdiction of Works Department; (26) preparation of complete record of all substructure street conditions; (27) steps to expedite the performance of public works; (28) substitution of unit-cost for "lump-sum" bidding; (29) substitution of city work for present contract system in laying water mains; (30) revision of laws relating to local improvements in order to (a) stop the present practice of charging a part of maintenance against abutting property, (b) avoid the necessity of paying for repaving and reconstruction by local assessments, (c) get away from frontage plan of assessments; (31) adoption of a definite programme for track-allowance pavements, looking to substitution of approved modern construction for present costly and inadequate methods; (32) adoption of a municipal civil service.

The Clay-Workers' Convention

AS announced editorially in our last issue, the Canadian National Clay Products Association are now holding their Twelfth Annual Convention at the King Edward hotel (Tuesday, January 27 to Friday, January 30). In addition to the general discussions and social features, addresses and papers are scheduled to be delivered by the following gentlemen: Mr. Herbert N. Casson, New York City; Professor Orten, Columbus, Ohio; Mr. M. E. Gregory, Corning, N.Y.; Mr. Joseph Keele, Toronto; Professor M. B. Baker, of Kingston, and Professor Day, of Guelph; Dr. M. C. McKay, Principal of the Technical School, Toronto; Mr. John Millar, Clayburn, B.C.; Mr. John F. Wilde, Calgary, Alta.; Mr. Miller Gibson, Waterdown, Ont., and Mr. A. F. Greaves-Walker, Toronto. Many of these gentlemen are in the very front ranks of clay experts and altogether the meeting promises to be of the most interesting of the kind ever held in Canada. Mr. John Millar is a brother of President Chas. A. Millar. Formerly he was manager of the Don Valley Brick Works, but he has been in British Columbia for some years and doubtless he will have much of interest to relate concerning the clay resources and operating methods of the far western province. Professor Orten, of the University of Ohio, will speak on the subject of Ceramic Courses and his remarks will be timely now that arrangements are being made for providing clay-workers with educational facilities in Toronto's new technical school. Professor Day, of Guelph, the tile expert; Mr. Jos. Keele, of the Geological Survey; Professor Baker, of Kingston, and the others are too well-known to require any further introduction at our hands. A report of the meeting will be published in our issue of February 4.

"English as She is Writ"

ENGLISH is a subject deserving of more attention than is given to it by the average engineer. One would think that in an age when slang is tolerated so freely, the engineer, trained in habits of accuracy, would set an example in the use of clear-cut, precise sentences conforming to the fundamental laws of his tongue, but this is true only to a degree: there is still a great deal of room for improvement. Both engineers and contractors must realize that their only effective advertisement is in a lucid description of their work, their style free from ambiguities and other shortcomings. It is in the best interest of us all to aim at a higher standard in this direction, both for ourselves and the next generation. The subject is called to mind by an able editorial in the Financial Times from which we extract the following:

"The English currently used in business correspondence in this country is an unmitigated outrage, not only upon all the canons of literature, but also upon all the dictates of common-sense. It is not for us to condemn it because it is not beautiful—a business letter, to fulfil the purposes of its existence, does not have to be beautiful—we condemn it because it is meaningless, obscure, indefinite, crammed with technical-sounding but inapplicable phrases, weighted down with clause upon clause so carelessly tacked together that the structure and meaning of the whole are completely invisible. Hundreds and thousands of men of the shrewdest business insight and keenest judgment fail miserably when it becomes necessary to communicate what is in their minds to some other party on a sheet of office notepaper. Half of the tearing up and down the country that fills our Pullman cars and prematurely greys the hair of our commercial magnates is the result of their instinctive distrust of their own ability to explain themselves by correspondence. A vast number of them sketch their ideas vaguely to a trusted stenographer who has a good general idea of the workings of their minds, and leave it to her (or to him) to elaborate the final expression; but such stenographers are hard to get and hard to keep, because the average stenographer's ignorance of English is second only to that of the average business man.

"There is not sufficient value attached to a knowledge of the English language. One reason for the high average of success attained by newspaper reporters who leave that vocation for commercial or financial careers is the fact that they have been engaged for a time at least in the one business in the country in which the use of English (poor it may be, but still English) is an essential function. For a year or two they have been obliged to express ideas in intelligible words. We hope some day to see the art of expression restored to its proper place as one of the prime essentials of a business education. By that time, of course, a "business education" will be something entirely different from the preposterous cramming with crude technical facts which now usually passes under the appellation."

Engineering Topics in the Old Land

A Discussion of England's Social Problem Which Reveals the Relatively Stable Character of Canadian Development

By Our London Correspondent

SIGNS are not wanting of the awakening of the Old Country to the fact that her status in the world's markets is seriously threatened. Two keels to one—or twenty to one for the matter of that—is a secondary matter in comparison with efficiency of production. Self-preservation is the operating motive in both cases, but while efficiency of production is necessary for the keels, the reverse does not necessarily follow. In any consideration of the question three primary factors enter, and we purpose dismissing in as few words as possible at least two of them. Efficiency of design and modern methods of production (the two may be taken as one and indivisible) is the first of these, and while we think that the productions of the Old Country compare favorably with those of other nations so far as design goes, we feel that sound business methods are only too often woefully lacking. Standardisation, too, which is quite a feature of Continental work, might be studied with advantage. Extension of her markets is the other of these factors, and here the Old Country is far behind her rivals on the Continent. A limited market means restricted output, with consequent high cost of production. The larger the field that can be covered, the greater the possibilities. To live merely in the present is, in things commercial, to live in a fool's paradise. An eye and a half must ever be on the future, and foreign firms recognise this to the full, as witness the undeniable fact that their representatives are to be found in every corner of the habitable globe. Ce n'est que le premier pas que coute—it is the first step that is the most difficult—and, as even the humblest drummer knows, a footing once gained the rest is comparatively a walk-over.

Co-operation Between Capital and Labour

We come now to the third of our factors, due co-operation between capital and labour, and almost insuperable difficulties at once present themselves. Capital is after all only stored-up labour. Capital cannot be self-created. Plant it in a soil ever so favourable to germination and not a bud or a tendril will be raised in a million aeons. Labour, and labour alone, can fertilize it, and under the fostering care of labour there is no limit to its growth. And the converse applies, to a lesser degree, to labour. Without capital—in the form of tools, plant, power, food and clothing—labour in a civilized community is valueless. Fruit is not to be had in towns for the plucking, and the most persistent rearing of flocks would fail to supply any but quite a small proportion of a nation, owing, among other things, to the difficulties attending transport. Primeval conditions can no longer obtain, in short, and it would be waste of time further to dwell upon them.

In a country such as Canada, a man has possibilities. His horizon is, so to speak, unlimited, and he may reap at least a welcome proportion of what he sows. Even in the worst-paid occupations, his wage is a living one, and the rewards of agriculture are not limited to rheumatics and the union workhouse. That there will be out-of-works and work-shys is one of the regrettable features of advanced civilization, but it must be remembered, as a set-off against this, that famine, rapine and bloodshed are practically extinct. Turning to the Old Country, we find that a large proportion of the population is in a state of chronic or partial starvation. There are tens of thousands of families that stolidly and heroically face the fact, from year to year, their life through. The casual labourer is of the type, and gaunt suffering may be traced in every line of his face, tragedy in his sunken cheek and hollow eye. Even the skilled worker does not escape, and in many trades work is uncertain and insecure, while wages are the lowest that can keep body and soul together. A week's unemployment spells discomfort, a month's unemployment disaster. Strikes and lock-outs have been a distinctive feature of the year that is past, and in the year that is with us the very gravest trouble is likely to occur. There is no blinking the fact that the English worker has got the bit between his teeth and he is racing both himself and his employer fast to perdition. That things are unequal cannot be gainsaid. Vast wealth on the one hand and bitter poverty on the other betray callousness of a most reprehensible nature. Mansions lie cheek by jowl with hovels, and wanton waste forms the necessary complement of woeful want. Shoemakers are shoeless, clothing hands naked, food producers starving; with plenty there is famine, with redundancy want; and none can see a way out of the infernal tangle which is sapping the strength and resources of the nation.

Due co-operation! In that alone lies the solution of a problem which yearly grows more and more acute. The small manufacturer, the single (as against the multiple) shopkeeper, the home worker—all are at their wit's ends how to bring about the meeting of ends. To pay a worker more is beyond their power. There may be the will, but the deed is undoable. Foreign competition is too strong, with its low wages and the lower standard of living of the workers. Profits, too, increase numerically as time goes on, and goods will pass through half-a-dozen hands before they reach the consumer, and at every change a profit will be expected. Steadily, too, the octopus companies are spreading their tentacles, embracing all, regardless of all. Small businesses are going to decay and large ones are threatened. Trusts rule the market, and the man who attempts to beard them is starved out. The actual worker simply doesn't count. He is a necessary evil, the sport of fortune, and is cast aside when his limbs lose their suppleness and his muscles their vigour. The apprenticeship system is dead, and the reaction inevitable in the transition from a state of ignorance to one of so-called education is yet keenly felt. The lower forms of unskilled labour attract both sexes, not simply because they are easier but because a wage may be obtained at once and a few shillings added thereby to the family coffer. Employers raise the cry that they cannot obtain the skilled labour that they require, oblivious of the fact that they are by their very methods crushing any possibility of supply.

Radical Changes Necessary

What supremacy the Old Country has in the world's markets at the present time is, we are much afraid, on the decline, and radical changes alone can conserve that which still remains to her. Obsolete methods must go by the board, and the push and enterprise of the younger nations must be adopted. The workers, and especially those of the rising generation, must be given a fair reward for their labour, and they must have some security against evil times and old age. To ask a man on a bare living wage to provide against unemployment, sickness and old age is to ask the impossible. The multiple traders, the ground landlords, the non-producing landowners must forego some of their profits, and to the small man must be restored as far as possible what was once his. Foreign competition is too keen to permit a continuance of present conditions, but while the capitalist must rest content with smaller profits the worker must put his shoulder to the wheel and cease from disorganising the machinery of commerce by demands which cannot be met without risk of national bankruptcy. Only by working harmoniously and whole-heartedly together can efficiency of production be obtained. Greed on the one hand and stubbornness on the other are a fatal combination. Malignant growths of long standing call for the knife of the surgeon. In sharp and swift remedy lies the only hope of cure, and the Old Country has been sick for many years. We can but wish her a speedy and full recovery!

In depositing concrete in deep water through a funnel the most difficult part of the operation, says the Engineering Record, is filling the tube at the start. As is well known, unless the tube is sealed in some way the cement will wash out during the downward passage and leave only a pile of stone and sand. This waste of concrete may in the case of a 12-in. tube 50 ft. long amount to more than 1 cubic yard. A simple but effective method of preventing this waste was described at a recent meeting of the American Railway Bridge and Building Association at Montreal. A 7-in. or 8-in. layer of wood shavings is first inserted and is covered with about 1-in. of cement. This forms a plug, and as the concrete is dumped on top the buoyancy of the plug and resistance of the column of water underneath prevent the first concrete from falling rapidly enough to wash out the cement; from then on the concrete itself serves as a seal.

Bush-Hammering to Relieve Concrete Surfaces

THE effect of bush-hammering a concrete surface is well illustrated in the factory of the Wabash Screen Door Company, at Minneapolis, Minn. No attempt was made to obtain an especially artistic structure, but rather, one of maximum utility and permanence, so that huge window areas predominate with concrete spandrels at each floor level, set back a few inches from the concrete beams and columns. The design is strictly utilitarian, yet susceptible to treatment to bring out a measure of architectural fitness, if not actual beauty. The treatment consisted of bush hammering all surfaces, except bands which were left plain for contrast. The roughened concrete with some color exposed in the coarse aggregate, combined with the smooth untouched surfaces, and the play of light and shade due to the shallow reveals, has imparted a distinctly pleasing effect, which is noticeable both at a distance and at close range.

The concrete is a 1:2½:3½ mixture using crushed blue limestone and was placed in ordinary forms. After thorough hardening it was bush hammered from a suspended platform, the edges being protected by strips of wood. The cost was about eight cents per square foot, rather a high figure but occasioned by the many small and narrow surfaces. Five to six cents is a usual figure.

Bush hammering has still greater possibilities, in that different colored aggregates may be used in panels and columns, the process adding contrasts of color to the rich texture. Black and red granites and feldspars, colored marbles and other aggregates not commonly used offer every possible color range and should open up a wide field for architectural expression. To embody such decorative features in the structural frame, integral with the necessary elements of the building is the most practical and fundamentally logical means of decoration and far more correct in principle than the application of veneer which has no structural meaning.

To combine the strength and permanence of concrete with the beauty of natural stone, in a monolith, is approaching the ideals of the Greek builders who countenanced no shams, using marble in solid blocks and only in shapes which the structural design demanded. The architect of to-day has all the natural stones at his command and an ideal matrix into which they may be incorporated—concrete. This same matrix is an ideal construction material, suitable for residence, factory, office building or garden wall. Such a construction has the added advantage of comparatively low cost, which makes such decorative work possible in factories as well as in the higher forms of construction.

The Beautifying of Highway Bridges

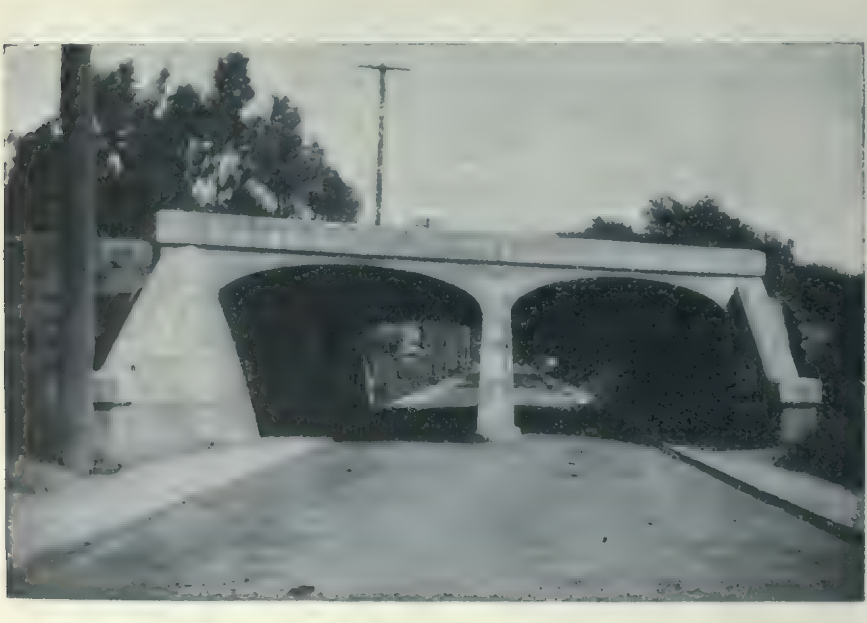
Increased Attention Given to this Subject following Activity in Road Work in Recent Years—Hints on Aesthetic Bridge Design

By Henry Grattan Tyrrell, Consulting Engineer, Chicago

HIGHWAY bridges, even in the rural districts, are coming to have a greater claim on public attention, owing to the general impetus in road-building and extension. In the following paragraphs some rules are therefore given as a guidance in aesthetic bridge design, most of them being based on Tyrrell's Artistic Bridge Design, and Tyrrell's History of Bridge Engineering.

Taste for the beautiful depends on environment, and the character, culture and education of a people are frequently revealed in their constructions. Those who live in primitive and rustic surroundings usually have their aesthetic taste less highly developed than their more favoured brothers in the vicinity of educational centres. Unfortunately, fashion often influences in constructive matters as in other things, and the prevailing fashion in bridge building, in America at least, is the unsightly framed truss with gaunt and awkward outline. This type is fortunately no longer necessary, for certain rules of aesthetic design have recently been developed and established which but few engineers have yet had the time or the inclination to investigate. Their application to steel framing has heretofore received little attention in America.

The blending of different materials in a single structure is often difficult, but in the little park bridge at Madison, N.J., designed by the writer a few years ago, the blending was so arranged that the general effect is harmonious. The centre span is a steel arch, while the abutments are rough-faced stone work and the steps concrete. It is located in a city park over two lines of railway and is surrounded with plants and shrubs, making the effect quite pleasing.



Curved wing walls and balustrades with terminal ornaments would have greatly improved this design.

The condition and character of bridges, roads and other public utilities have been measures of civilization in all ages. The homeless savage in trackless wilds had little need for bridges, as his wants were few and achievements small. But as civilization dawned, human needs increased and the desire for greater comforts, better homes and surroundings, created a need for transportation and communication. The bridge of fallen logs or swinging vines gave place to better and more commodious ones over which loaded animals and carts could pass in safety. With the further advance of civilization and the extension of commerce, heavier and better bridges were required until the coming of railroad transportation in the nineteenth century, when stronger ones were erected to carry trains of cars and locomotives. The earliest bridges, like houses and other structures, were for utility only, and little or no thought was given to their adornment. Primitive races were content with homes which merely sheltered them from the storm and with rude bridges which served only their barest needs, but succeeding generations produced buildings in which utility was combined with art. But while houses have been adorned and made architecturally attractive, the beautifying of bridges has not advanced in proportion to other arts. Many cities which have splendid buildings, streets and parks, are disfigured with utilitarian bridges, wholly void of art and worthy of existence only in remote regions. The

Pontoon bridge over the Rhine at Cologne. More attractive than an unsightly one of steel.

Bridge at entrance to Como Park, St. Paul.

Bridge in Golden Gate Park, San Francisco. The view shows the ornamental balustrades.

A two span concrete bridge with ornamental balustrade.

greatest lack of art in bridges is found in America and other new countries where the need of rapid construction has prevented aesthetic treatment.

Great bridges are a distinctive feature of modern cities, and according as they are attractive or not they influence public estimation of the place where they are located. The beautiful bridges of Paris, Berlin and Budapest are of enough interest in themselves to attract travellers to those cities, and the bridges over the Rhine are among the principal features of the region. The bridges of these cities, and others, such as New York and London, are more conspicuous, especially from the water, than all their great buildings which have cost untold millions.

A common form of public disfigurement inflicted upon communities by the railroads.

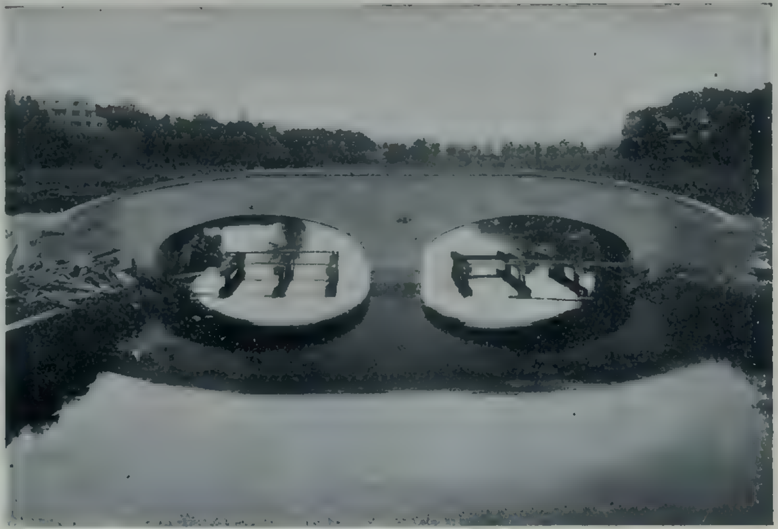
The founding and building of empires has always been dependent on roads and bridges. The Romans saw that the requisites for a great nation were a fertile soil, natural resources and abundant means of transportation, and the excellence of the Roman roads has scarcely been surpassed. Their roads and bridges have endured for more than twenty centuries and are used by the present generation. The building of roads and bridges, therefore, has been the greatest factor in the development of nations and empires, and the condition of these utilities has always been a measure of their civilization and greatness.

Bridges are frequently the most conspicuous objects in the landscape. Unlike buildings in crowded city squares, which are partly concealed by their surroundings, a bridge can often be seen for a great distance. The greatest injustice to public taste or feeling is the building of an ugly bridge, for the most prominent and useful structure should be the most beautiful, and yet the reverse is too often the custom. City halls, post offices, and other public buildings have been adorned, and bridges have been neglected. A city should realize that it is as important to beautify its bridges as its court-house or city hall. Great terminal depots are often erected in the cities and beautiful though smaller ones at suburban stations, while adjoining bridges, which are often more conspicuous than the depots, are left utterly unadorned.

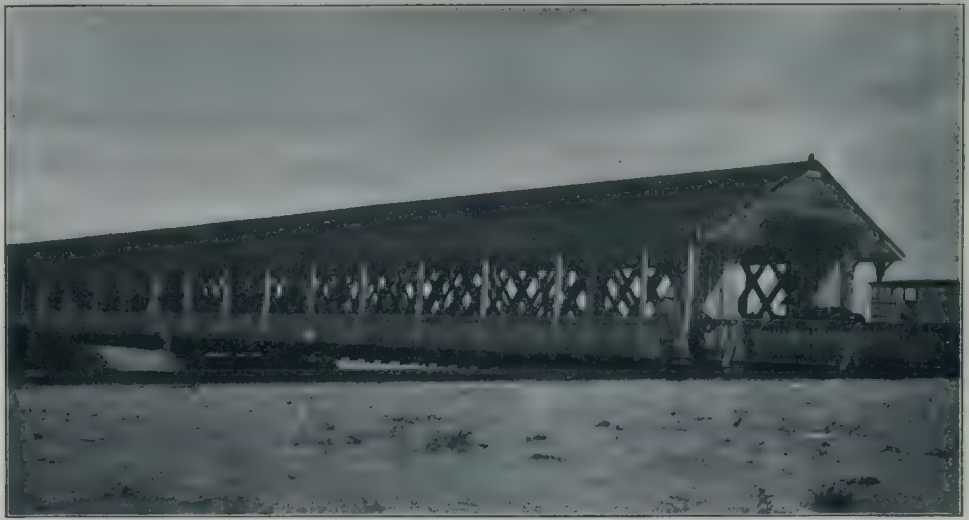
Bridges should be made ornamental because their form and location are so frequently inviting for artistic treatment. The curved lines of the arch and suspension are in themselves attractive and may be further beautified without much effort. It is easy, therefore, to make a bridge one of the most beautiful and interesting features in a landscape. No structures show more clearly their object and use, and the opportunity is therefore offered for truthful construction, a prime requisite for good design. Bridges, and especially high ones, are naturally impressive, and no objects in a landscape are longer remembered. Returning travellers often retain the memory of a bridge long after monumental buildings have been forgotten.

Bridges should be made beautiful, because people delight to congregate and loiter there, particularly in the summer time. For this reason a bridge is especially suitable for a memorial structure, as it can be appreciated and admired during leisure hours. Bridges should

A concrete arch with too flat a rise. The metal balustrade gives it a very light appearance.

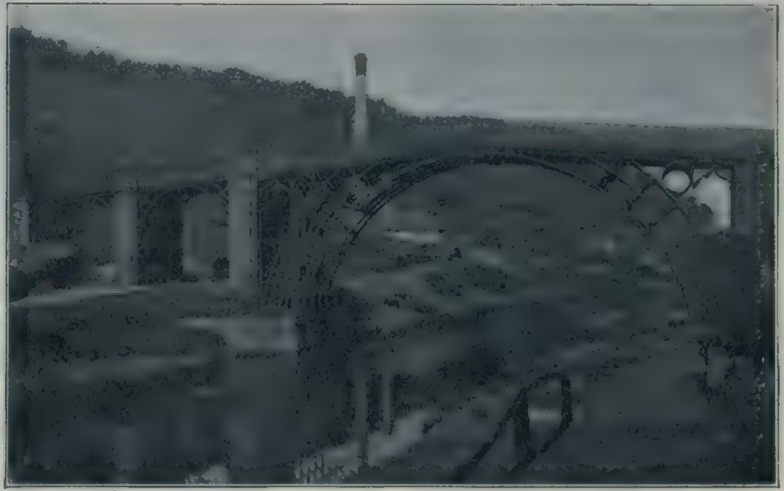


A bridge with cambered and curved wing walls.



Old covered bridge at Grand Rapids, Mich. A type which generally outlived those of steel.

Pontoon bridge at Weed street, Chicago. Disfigurements of this kind may still be seen in many of our cities.



Bridge at Coalbrookdale, England. The first iron bridge ever built. More attractive in appearance than many modern ones.

Bridge at Reno, Nevada. Three spans would have looked better.

A bridge at Pasadena, Cal., with ornamental features at the ends. Photo made during repairs.

be beautiful because the presence of ornamental structures enhances the value of the surrounding property. City officials who have the expenditure of public money should realize the economy of building artistically in and around large centres of population, for money thus spent is frequently a good investment. Fine bridges give a distinctive feature to a city. Those in France and Germany, and some few in America, show possibilities in artistic steel construction. The thirty-two bridges over the Seine at Paris are in most cases models of elegance, standing out in sharp and charming contrast to those in some American cities. But the time for better ones is at hand. Utilitarian bridges, which were excusable in the early days of this continent, should no longer be tolerated. The wealth and commerce of America have so greatly increased that the uncouth forms of past generations are no longer permissible as representative works of a great nation.

Some of the reasons for lack of beauty in American bridges may be stated as follows:

(1) Little or no literature on artistic design has been available and no instruction on the subject has been given in engineering schools. Ugly designs, therefore, are often made, when beautiful ones would cost no more. After selecting a form which is far from the proper one, many engineers are accustomed to compute the stresses in the various parts, even to decimals, when the assumptions may never be realized within one hundred per cent.

(2) Commercialism and competition are responsible to a great extent for a lack of art in American bridges, for as a general rule the cheapest bridge, and consequently the plainest one, is usually accepted, and ornamental designs at greater cost are discarded. Ugly designs are usually prepared by contractors' engineers, whose only motive, frequently, is their personal gain.

(3) Hasty construction is perhaps responsible for more ugly bridges than any other cause. New districts have been opened up by projecting long lines of railroad across the continent, the rapid completion of which has often been dependent on the bridges over which work trains and supplies could pass, and hasty construction has often been imperative.

(4) The American railroad bridge with simple

Foot bridge, Garfield Park, Chicago.

An attractive design for a park bridge. Photo taken before completion.

trusses which could be built quickly became the prototype for town and city bridges, and these ugly structures may now be found not only in the country districts but also in and around important cities.

(5) A common excuse for unsightly city bridges is that of insufficient funds or appropriation. This plea is usually without foundation, because cities which spend millions on their public buildings could better afford to beautify their bridges, which are often much more conspicuous.

Bridges have had many uses in addition to forming a passage-way for travel, and ancient ones were frequently lined with shops, or used as a gathering place for citizens. Old London bridge, and others at Florence and Venice were roofed over, and provided with stalls or shops for merchandise. Others had memorial arches, chapels, or fortification towers at the ends, an American example of great merit being the memorial bridge at Hartford, Conn., standing in Capitol Park.

Statuary is a common adornment on the bridges of Paris, Berlin and other European capitals, but features of this kind are noticeably absent in America, only very few containing anything more than simple structural requirements.

When the writer was asked some years ago by the authorities of Copenhagen, St. Petersburg and Sydney

Jefferson Avenue bridge, South Bend, Ind. A very attractive design, though restricted with small arch rise.

to prepare designs for bridges in those cities, the invitations were declined with great reluctance because of the opportunity for artistic design which is usually acceptable in the capitals of foreign countries. In this connection it is interesting to note that the accepted design for at least one of the bridges—that over the Neva at St. Petersburg, Russia—was the work of an American engineer.

Replacing a Three-Span Cantilever Bridge in British Columbia by an Independent Span

ELIMINATION of falsework was the constructional feature in replacing an old 315-ft. bridge span over the Fraser River on the line of the Canadian Pacific Railway, 150 miles east of Vancouver, B.C. The end spans were supported during erection on the old structure and afterward served as anchor spans to counterbalance the main span during its cantilever erection. Erection adjustments of the center panel were made by screw toggles.

The railway follows up the north bank of the river until the canyon swings around toward the north to such an extent that a crossing becomes necessary. The bridge site selected by the locating engineer in 183 has proved to be well adapted for a crossing, as it is one of the narrowest places on the river and has the advantages of giving a good alignment and solid rock foundations.

The original cantilever bridge was erected in 1883-84, the piers being placed close to shore, giving a main span of 315 feet. This location of the piers made it possible to use anchor spans 105 ft. in length, running from the piers to stone abutments, and two cantilever arms and a suspended span—all three of which being 105 ft. long. Thus the bridge had a total length of 525 ft. between abutments. The structure has been in constant use from the day of its completion in 1884 until 1910, when the use of heavier engines and rolling stock made a change necessary.

The old site was considered the most suitable for the location of the new bridge, and it was decided to erect here three through trusses, using the same masonry, with some slight additions, which supported the old bridge. The two short end spans were erected first, using the anchor arms of the cantilever as falsework. The 315-ft. through span was then erected by weighting down the short spans (specially designed for this stress) with old rails and connecting the top chords of adjacent spans by means of a temporary toggle joint which linked up the steelwork so as to employ the cantilever principle during erection.

Four toggle joints were required, each consisting of eight 1½ x 6-in. eyebars connected to steel pins in the end posts and at the center, as shown in one of the illustrations. Four pins were used at the center, each pair being carried in a frame in which was fastened a nut engaging a thread on a vertical shaft operated by a bull-wheel. By turning this wheel the angle of the toggle joint could be changed at will and the span under construction lowered gradually into place from both ends until the two parts met in the center and were coupled up. The maximum weight of rails put on each short span was about 400 tons.

During the course of erection the traffic averaged from eight to ten trains per day, and was maintained without any delays. After the new bridge was completed and ready for service the old bridge was taken out, piece by piece, and utilized on the Esquimalt & Nanaimo Railway, a Vancouver Island branch of the Canadian Pacific Railway, on which lighter rolling stock is used. The piers which were used for both the old and new bridges over the Fraser River are about 82 feet high and are founded on solid rock exposed on the shores of the stream. The difference between low and flood level of the river under the bridge is 67 feet, the lowest water record being 125 feet and the flood 58 feet below the deck.

The cost of the original bridge, including masonry and steel, was approximately $270,000, and the cost of replacing the steelwork is estimated at $160,000. The new bridge was fabricated by the Canadian Bridge Company according to designs prepared by Mr. C. N. Monsarrat, engineer of bridges for the Canadian Pacific Railway. Mr. C. E. Cartwright was division engineer, succeeded by Mr. H. Rindal, and Mr. H. B. Walkem, resident engineer, was succeeded by Mr. F. P. Wilson.—Engineering Record.

Experiments in Waterproof Concrete

A SERIES of tests to determine the rate and the amount of flow of water through concrete is being made by the College of Engineering of the University of Wisconsin, Madison, Wis., with the object of finding a simpler means of making concrete watertight. Some interesting results have already been secured in the effect of the length of the time of mixing in a machine mixer of the batch type; the effect of the percentage of water upon the imperviousness of the concrete; the effect of having sand in dry condition before mixing; and the effect of having the sand wet.

It has been found that good results are obtained if the concrete remains in the mixer from two min. to three min. when dry materials are employed. For cases in which the sand and gravel or stone are damp a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. The experiments show that 1:1½:3 mixtures consisting of cement, Janesville sand of the torpedo grade, and Janesville gravel, when mixed to a wet consistency, are impervious to water when subjected to a pressure of 40 lbs. per sq. in. Mixtures as lean as 1:6, using a graded gravel, have been made impervious at high pressures by using care in proportioning the amount of water and in mixing the batch.

The specimens used in making these tests are cylindrical in form and so made that the faces of the cylinders, which are 13½ in. in diameter, are exposed to the pre-determined water pressure. The thickness of the concrete through which the water must pass can be varied from 4 in. to 18 in. Ample provision is made for cleaning both faces of the cylinder before placing it upon the testing apparatus. The apparatus itself is so arranged that very accurate tests can be made.

The importance of these experiments will be more sufficiently appreciated when it is understood that a large proportion of the trouble arising from poor concrete is due to the use of defective sand or gravel.

The nuisance of speakers at technical and scientific meetings exceeding the time limit was obviated in an ingenious manner at a recent conference on safety and sanitation in New York. By means of an electric fixture on the president's desk a green light was displayed two minutes before the end of the allotted period of ten minutes, and a red light at the end of ten minutes. The speakers did not exceed their time.

Substructure Work for the Canadian Pacific Railway Bridge at Mud Lake, Ont.

THE Canadian Pacific Railway is building a low grade freight line between Toronto and Perth, Ont. The building of this railway requires the construction of a bridge across Mud Lake, about 150 miles northeast of Toronto. This bridge will consist of two main deck truss spans of 241 ft. 7 ins., and several shorter approach spans. Figure 1 shows an elevation of the structure and indicates the character of the subsoil. The total length of the bridge between the abutment parapet walls is 953 ft. 7½ ins. The superstructure is supported on four concrete piers, two steel towers and concrete abutments. The foundation work was especially difficult owing to the soft character of the subsoil and to the depth of bed-rock.

Description of Site and Subsoil

The geological conditions at the site of Mud Lake are interesting. The lake is surrounded on three sides by high hills and derives its name from the semi-liquid mass, extending almost from the surface of the water to hard-pan, which lies about 86 ft. below the surface at the lowest point (at pier No. 2). Although the route through the lake presented difficult foundation problems, it was chosen in preference to an alternative location among the surrounding granite hills, chiefly because it gave much lower grades. The site of the bridge is about six miles from the railway station, which required that the entire plant and all supplies be transported by wagons over the hilly country.

Construction Equipment

The main plant comprised three 90 h.p. Loco boilers weighing about 20 tons each, two air compressors of about the same weight, a 1-cu. yd. concrete mixer, a stone crusher, derricks, a narrow-gauge working track and cars, quarters for the men, a hospital lock, etc. The sand for the concrete was obtained from a pit about two miles from the bridge site and was delivered in wagons. The stone was quarried from the granite hills and was crushed at the site. The concrete mixing plant was located at the west end of the bridge, the concrete being hauled in dump buckets on cars over a narrow-gauge track. This track was supported on a pile trestle, built across the lake. The materials were handled with stiff-leg derricks.

Construction of Caissons and Piers

Preparations were started on January 13, 1913, for the construction of the foundations of the bridge, and work was actively started in March, 1913, of which operations were continued night and day until about the first of August. The sinking of the caissons under air pressure presented difficulties on account of the low resistance of the subsoil, both in friction and in compression. In density, the mass could well be classified as soft, blue clay.

Three of the four piers, Nos. 2, 3 and 4 (see Fig. 1 for location) were sunk under air pressure; No. 2 to a depth of 103 ft. 4 in.; No. 3 to a depth of 59 ft., and No. 4 to a depth of 40 ft. below the surface of the lake. Except for the lower 13 ft., which consisted of quicksand and boulders running into hard-pan, the displaced materials were liquid muck and soft blue clay (see Fig. 1). The foundations for pier No. 1 and for pedestals Nos. 5, 6, 7 and 8 were sunk in open cofferdams, constructed of sheet piling.

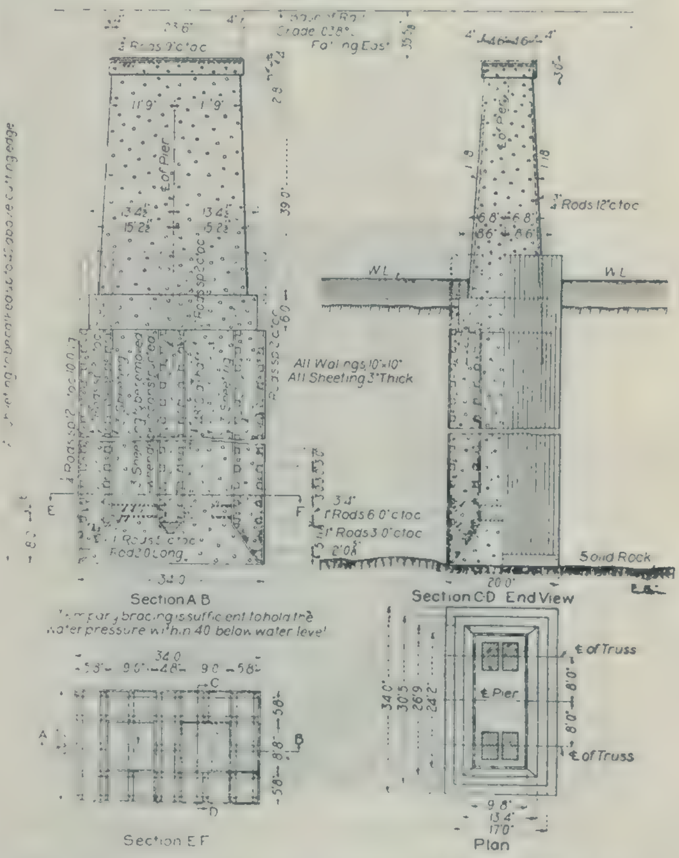


Fig 2 —Plan and sections of caisson and dimensions of pier No. 2.

The caisson for pier No. 2, which required the deepest foundation, was 34 x 20 ft., outside dimensions, and

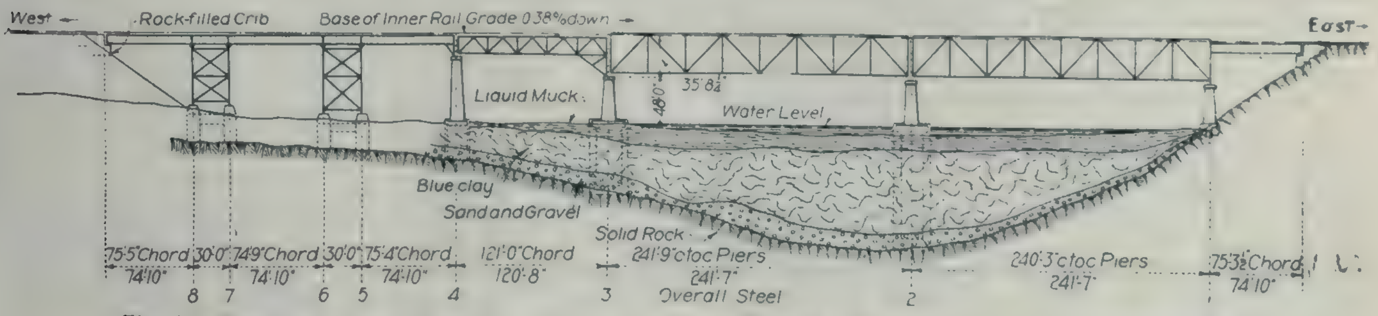


Fig. 1.—Elevation of bridge over Mud Lake, Ont., showing type of construction and character of subsoil.

was provided with two dredging compartments, each 8 ft. 8 in. x 9 ft., inside dimensions. Fig. 2 shows a plan of this pier, its foundation being constructed of 1:3:5 concrete and the pier proper of 1:2:4 concrete. The drawing shows the general features of the pier and the construction details of the caisson. Owing to the softness of the subsoil and to the necessity for a quick sinking of the caissons, they were braced and sheeted like an ordinary wooden cofferdam with a steel cutting edge, the walls of the working chambers being reinforced with rods, as shown in Fig. 2. The work of sinking the caissons was carried on continuously day and night, as no forms were required. After the caissons were dredged to a depth of 40 ft., it was decided to place the reinforced concrete dock. A view, looking west, of the caisson for pier No. 2 is shown in Fig. 3. This view shows the method of excavating the material and also shows a portion of the working track. The shafting for the deck of the caisson was embedded in the concrete and was carried to a point above the water level, on top of which was placed the air lock. The concrete for the deck was placed under water, even though it was accomplished with considerable difficulty, the remaining 63 ft. being sunk under air pressure. The maximum pressure required for the sinking of pier No. 2 was 47 lbs. per square inch. Great care was exercised in choosing men for this work, and only those who had previous experience on caisson work were engaged. The length of time which the men worked under the maximum air pressure was 45 minutes. A hospital lock was installed at Mud Lake, and those afflicted with "bends" during the sinking of the caissons were at once treated by the usual air method.

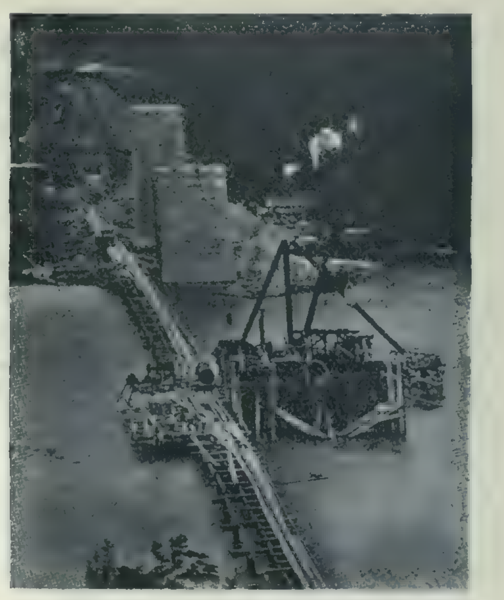


Fig. 3.—View of caisson No. 2, looking east.

The caisson for pier No. 3 was of the same size, except that the depth was much less, and the methods used for sinking it were similar to those just described. Pier No. 3, above the caisson, has the same dimensions as pier No. 2.

The work was carried on under the direction of Mr. C. W. P. Ramsay, engineer of construction, from the design of Mr. P. B. Motley, engineer of bridges for the Canadian Pacific Railway. The foundations were constructed by The Foundation Company, Limited, Montreal and Vancouver, Mr. A. I. Campbell, superintendent.—Engineering and Contracting.

Use and Cost of Concrete Pedestal Piles

In a thesis submitted for the degree of B.Sc. at the Georgia School of Technology, Atlanta, Ga., Walter Grady Miller presents a comprehensive report on the foundation for the Fulton County Courthouse, Atlanta. After discussing the general features of the building, the nature of the sub-soil, etc., he describes in detail the pile foundation.

The essential duty of the pile, according to the thesis, is to transmit a certain load which cannot be carried by spread footings on account of unreliable ground, to the firmer and more reliable sub-soil. It performs this duty by its direct bearing on the sub-soil under its base, and by the friction of its surface with the soil penetrated.

In the first case, the pile acts as a column loaded at the top by the footing, and transmitting its load to the firmer sub-soil at its base; in the second, the frictional resistance is transmitted to the sub-soil by a conoid of pressure. If the intermediate soil between the upper and the lower end of the pile happens to be a very soft clay or quicksand, the frictional resistance will be greatly reduced, and the load carried will depend chiefly on the bearing area developed by the base of the pile. It is thus seen that the pile with an enlarged base is in many cases a necessity while in many cases it is from certain points of view advantageous to use such a pile.

The Work at Atlanta

The successful bidder for the pile foundations on the work described was the MacArthur Concrete Pile & Foundation Company, which has developed in the last few years the pedestal pile. The essential feature of this pile is an enlarged base. In constructing this pile a heavy cylindrical casing is driven to the required depth, usually to refusal under a specified number of blows of definite weight. A batch of concrete is then placed in the hollow cylinder, to be followed by a rammer. The cylinder is raised a little and the rammer is driven downward, enlarging the base of the pile into a bulb or pedestal. This process is continued until a base of required size is developed, after which the vertical pile is completed by filling the cylinder with concrete and gradually withdrawing the casing.

One advantage of the enlarged base pile over the ordinary taper pile lies in the fact that the latter has a tendency to be "driven down" as a post with a sharpened end drives much more easily than one with a blunt end. An enlarged base pile, on the other hand, strongly resists any "driving down" action.

Methods Used in Pile Driving

The pile driver used on the Atlanta work consisted essentially of a steam hammer, suspended between two heavy timber uprights, which served as guides to hold the hammer in the proper position while raising or lowering it. The bottom of the hammer cage connected to the top of the core and the casing. The core was driven until 10 blows caused not over 1 in. penetration. The piles were so designed and placed that with the dead load and 50 per cent. of the live load on the building each pile would have approximately 25 tons on it.

Forty piles out of the total number driven were tested. The maximum settlement under a maximum test load of 50 tons was 3-16 in. Some piles were tested under a 35-ton load only. The tops of the piles were required to be of various elevations in different sections of the foundations, due to a sub-basement, boiler pit, etc., having low floor elevations. Under most of the footings, piles were staggered about 3 ft. on centers in order to get the required number within a minimum area, and this reduced the size of the pile cap covering them. In all cases, the center of the pile was required to be 1 ft. 6 in. from the edge of cap. Accepting 25 tons as the approximately correct load to be carried by each pile, the foundation of piles will carry (when the building is about 50 per cent. live loaded) something like 1,200 x 25 tons, or 30,500 tons load. The cost of these piles was for the first 15 ft. driven, an average of 85 cts. per vertical ft. For depths greater than 15 ft. a handbook issued by the MacArthur Concrete Pile and Foundation Company, states that as a rule, the prices will vary from $1 to $1.25 per lin. ft. of pile. For a very small or a very large job, however, the cost may run respectively higher or lower. In general the price per lin. ft. of the pedestal pile is as low as that of any other cast-in-place pile, and much lower than that of the cast-above-ground pile.

The Prevention of Dampness in Buildings

By George Melson, F.R.I.B.A.

ONE of the most important points to observe in building operations is that of keeping dampness out of all parts of the structure. The dampness may be caused by (1) there being no damp-proof course, (2) the damp rising from the ground, (3) the damp earth against the walls, (4) rain soaking in through porous parapet walls and copings, (5) driving rains against walls, (6) burst pipes or leaks in roofs and other causes avoidable by a proper state of repair being maintained. Beyond this last cause, which should never obtain at all, to attempt after the building is occupied to remedy any of the other five omissions or faulty construction is a costly operation. For example, the cost of inserting a damp-proof course into a wall constructed without one is about as five or six to one, according to the material used, as compared with the cost of putting one in at the time the building is erected.

The provision of a damp course is in most towns a necessity, as the building laws require one. Some of the materials in most common use for this purpose are a double course of slate in cement, sheet lead, hard blue bricks, glazed stoneware slabs or tiles, asphalt, asphalted felt, etc., such damp courses laid costing from about 3d. (6 cents) per foot superficial for bituminous sheeting (in rolls) to 1s. (25 cents) per same unit for thick sheet lead.

The chief point to observe is that the damp-proof course covers the whole of the wall, and in the case of slates that they are of a stout quality and correctly laid to break joints and are properly bedded above, below and between each with cement mortar gauged one of Portland cement to one of clean sand. For appearance sake, and to prevent a lodgment for rain, moss, etc., the slates are generally kept back one-half inch on the outside of the wall and the damp-proof course pointed up in cement with a flush joint. Too much care cannot be taken to ensure that whole slates are used (and new ones at that), for unless this is so a straight joint occurs; then if the cement-mortar cracks when set at this point water can ascend in the wall by capillary attraction.

It would appear to be a simple matter to lay a damp course of slates in cement, but it is a matter wherein an error in method can be made, and, as usual, it is one of those small errors impossible of remedying when covered up. The cement compo bed should be spread over the wall to be covered, preferably by the laborer, with the back of his shovel, or, failing that, by the bricklayer with his trowel, and at this point the bricklayer should commence the laying of the slates; but it is no uncommon practice for him to first of all cut the bed of compo across and raise it, as it were, into a series of small ruts or ridges, and on these to put the slates, tapping them home with the edge or the handle of his trowel. These ridges remain and set as such, and so the slates only have bearings at certain portions of their surface and invariably crack or snap at these points.

Sheet lead as a damp-proof course is the most expensive, as the lead should not be less than 5 lb. per foot super in weight. The bed on which it is laid must be smooth to prevent the roughness of the bricks or stones cutting through it, but at the same time its substance allows it to adapt itself to small irregularities of the surface on which it is laid. One disadvantage of this material as a damp-proof course is that under heavy loads it may squeeze out, and where this occurs the stones may spall off at the edges, for which reason the use of sheet lead between the beds of stones forming a column or pillar is now rarely used.

The cost of laying this damp course is certainly cheap, as it can be put to the exact width required, and the putting of it into position is a simple matter. Its great advantage, however, is as a damp course to be inserted into a wall built without one, where it can be rolled up and unrolled as required as in Fig. 1; but generally where such damp courses have to be inserted the cost of cutting out the brickwork is so high that in many instances the total cost is reduced by using a bituminous sheeting which can be similarly operated.

The use of a course of Staffordshire blue bricks set in Portland cement as a damp-proof course is by no means a good one, as even the best of these bricks are porous, and, this being so, dampness can rise through them. Even where the brickwork for some few courses below the damp course level are of blue Staffordshire bricks a proper damp-proof course should be inserted.

Glazed stoneware tiles or slabs, made to the width of the wall, form a good damp-proof course. They may be anything from 1 in. to 3 in. thick and are 9 in. long. Best stoneware of itself is practically non-absorbent, but when glazed is emphatically so. This material can also withstand heavy loads. Fig. 2 shows this type of damp-proof article, and Fig. 3 a part of a damp course formed of this material.

The perforations through the slabs are of great use, forming an excellent method of ventilating the underside, and particularly the corners and spaces under the wooden joists of ground floors so necessary if dry rot is to be avoided. Once more the bricklayer can spoil the efficiency of this damp-proof course in the jointing of the blocks or slabs. The groove or perforation at the joint is apt to become filled with mortar when moisture from the courses of brickwork beneath the glazed slab may rise up through this mortar in these vertical joints into the brickwork above and thus defeat the object of the glazed tile course at every 9 in. of its length. This defect is easily avoided by the foreman seeing that no mortar is put to this vertical joint, but that the hole or perforation is left quite clean and free from any jointing material. An attempt to overcome this difficulty on some jobs is often made by filling up the end grooves x and x in Fig. 2 with cement; but the cement as used is rarely of itself damp-resisting, so that this method cannot be said to get over the difficulty. Again, the cement joint may crack, when moisture can rise by capillary attraction, so it is much wiser to leave the perforations unfilled.

Asphalt as a damp-proof course is perhaps the best of all materials used for that purpose (excluding sheet lead on account of its greater cost). It is easily laid, is elastic to a certain extent, and yet able to withstand great pressure. There is also an entire absence of joints, and this is a particularly good advantage, as the joints in all other damp-proof courses are their weak points. At the same time care should be taken to see that the asphalt is from a reputable firm, as some are much too brittle, while others squeeze under a comparatively small load, nor yet can some withstand the heat as the better material can, and others are merely a mixture of coal-tar, pitch and sand.

Before any asphalt is laid the brickwork should be leveled, and it must also be dry and brushed clean, leaving the joints well flushed up with mortar. The course of brickwork to receive the asphalt damp-proof course should be laid with the frog downwards; in all other positions it is generally laid uppermost to insure it being filled up. The asphalt course should be of an even thickness, ½ in. or ¾ in., as may be specified, and to insure this correct thickness screeds must be fixed to the top edges of the length of the walls when the molten asphalt is poured on and surfaced with wooden floats.

In order to make quite sure of the perfectness of the jointing necessary say, from the leaving off of one day to the commencing on the following one, the last foot or 18 in. of the over-night work should be left but ¼ in. thick, allowing the next morning's work to complete the thickness insuring a waterproof joint.

Asphalted felts are serviceable as damp-proof courses, but care must be taken to see that the one used has a real claim for that purpose. Some simple tests to judge the quality and usefulness of some of the felts on the market are as follows: (a) To fold up the corners in such a manner as to form a tray, and if such tray will retain water for twenty-one days, leaving the underside of the felt perfectly dry, the sample may be considered good enough for its purpose; (b) pull the sample to pieces to see that each and every fiber is thoroughly coated with asphalt or bitumen. This last is important, as in the position in which it is to be used its edges would harbor insects, fungus, etc., if the felt was not saturated with bitumen to prevent it rotting. This liability to rot is one of the great

The Prevention of Dampness in Buildings, Illustrating Some of the Remedies Suggested.

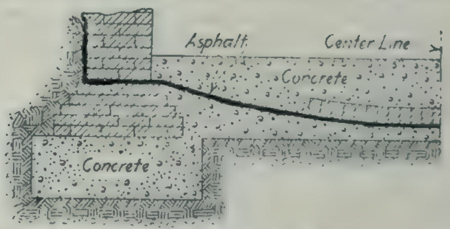


Fig. 7—Showing Arrangement of Damp Course to Resist Upward pressure of Water

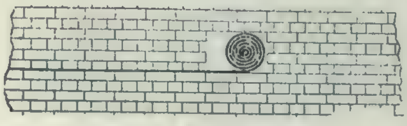


Fig. 1—Inserting Damp Course in an Old Wall

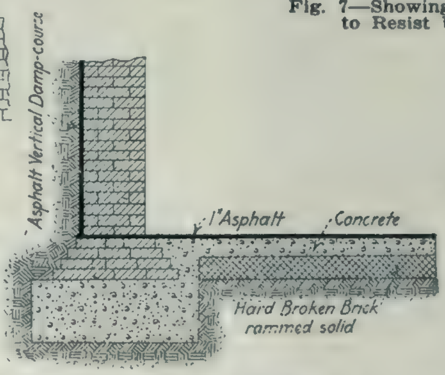


Fig. 6—Damp Course on Outside of Wall Below Grade and Extended Through Wall to Form Top Surface of Cellar Floor

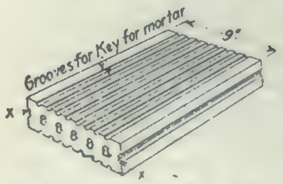


Fig. 2—A Glazed Stoneware Slab as a Damp-proof Course

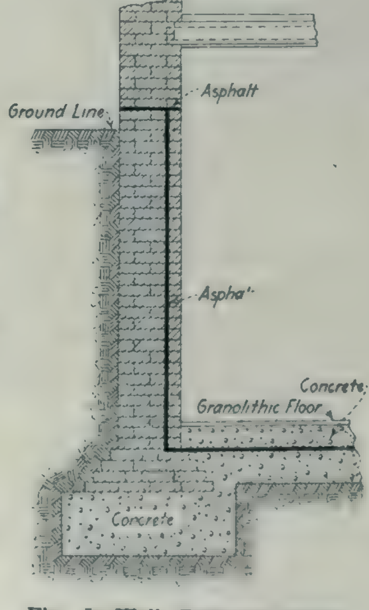


Fig. 5—Wall Rendered Damp Proof with Asphalt and Half-brick Built against it; or a space Left in the Brick Work and Hot Asphalt Poured in at Short Hights of the Work

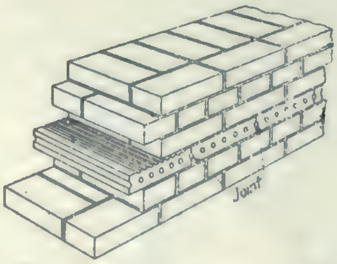


Fig. 3—Portion of a Wall Wherein the Slab Shown in Fig. 2 Is Used as a Damp Course

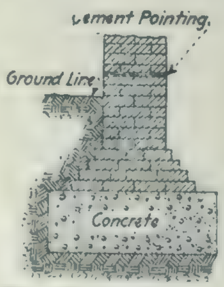


Fig. 4—A Damp Course of Slate

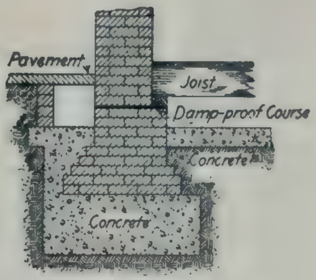


Fig. 8—Dry Area Where Floor and Pavement Are Practically Level

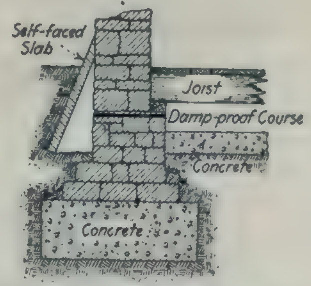


Fig. 9—A Cheap Form of Dry Area Common in Laminated Stone Countries

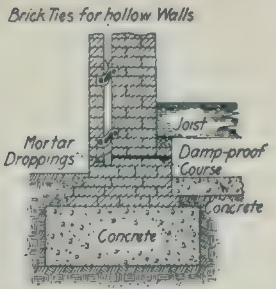


Fig. 10—Case Where Mortar Droppings Cause Dampness by Capillary Attraction

The Prevention of Dampness in Buildings.

disadvantages of felts as damp-proof courses, and as such some of the makes on the market hardly come within the meaning of the model by-laws of the Local Government Board, "or other durable material impervious to moisture," for which reason asphalted felts are not permissible in some towns as a damp-course material. Some of the best makes of asphalted felts are guaranteed by the makers as being both "durable" and "impervious to moisture."

The second heading mentioned as a cause of dampness in buildings is that of dampness rising from the ground. To overcome this cause of dampness the model by-laws provide for a layer of good cement concrete rammed solid, at least 6 in. thick, to be put over the site to seal the ground air.

The number of voids in soils, as also their power of holding water, varies; but it may be said that all contain in smaller or larger quantities certain volumes of "ground air" at the surface and "ground water" below. As the latter rises or falls, according to the heaviness of the rainfall, so the "ground air" in the pores, so to speak, of the soil rise and fall, being on occasions expelled from the ground; also this ground air is drawn from the soil beneath a house on account of the greater warmth of the rooms over the site; also a rising temperature or a falling atmospheric pressure may extract or draw out such ground air.

Ground air is always impure, often resulting from the decomposition or decaying of vegetable or organic matter, or from soakages from defective drains, cesspools, etc., hence the great need of the asphalting or concreting over the site, as required by the model by-laws.

The concrete used for this purpose must be "good," but it is certain that a large proportion of the concrete put over sites is mere rubbish, often being merely placed on top of the ground, the turf not even being removed. The by-law does not ask for the concrete to be floated to a smooth surface on top. It is to be regretted that it does not, as it would the better ensure, at any rate, the top half of the 6 in. of concrete acting effectively, as some of the concrete put down by speculating builders is deplorable.

It is possible that in basements the floor may be below the standing level of water, when, in addition to preventing the water entering the side walls, it may be desirable to make the basement practically a water-tight tank; and in cases where great pressure of water is found it may even be necessary to reinforce the concrete over the site in order to prevent it being lifted by the upward pressure of the water. Several methods of making basements water-tight are shown in Figs. 5, 6 and 7.

In these same illustrations are shown methods of sealing the basement side walls against dampness coming in through them by reason of the damp earth next them, which was mentioned as the third cause of dampness in buildings. Some such provision is always necessary when the lowest storey of any building is below the level of the surface of the ground. In the words of the model by-laws, "that where any part of a floor of the lowest storey of such (new building) shall be intended to be below the level of the surface of the ground immediately adjoining the exterior of such storey, and so that the ground shall be in contact with the exterior of such wall, he shall cause such storey to be enclosed with double walls, having an intervening cavity between such walls of a width of 2½ in., and extending from the base of such walls to a height of 6 in. above the surface of the ground immediately in adjoining the exterior of such storey."

Several forms of cavity walls and dry areas are shown in Figs. 8 to 13.

Care must be taken to observe that mortar fallen into the cavity between the two thicknesses of brickwork does not defeat the object of the hollow ways by allowing moisture to be drawn across it and up the interior wall by capillary attraction, as shown in Fig. 10.

Dampness of Parapet Walls

Parapet walls are generally built of facing bricks —at any rate, on one side—and this class of brick is more frequently porous than that used for the general brickwork, so consequently it behooves the architect to find some means of preventing water penetrating downwards through the brickwork forming the parapet. One method is to build the whole of the parapet wall in cement-mortar, and, even better still, to insert one of the damp-proof courses already mentioned. Even when stone copings replace brick-on-edge and tile creasing the same need for keeping water out obtains, the stone being porous. Where it is possible it is much preferable for the slates to go over the gable ends of walls and form verges rather than have parapet walls to them.

Driving rains are a very common cause of dampness in buildings, particularly where the latter are in exposed positions. This condition may be met by building with hollow walls or by tile hanging them. Where the need of prevention of dampness from this cause has been overlooked resort has to be made to covering the walls with slates or tiles afterwards.

Other endeavors that have been tried are applying hot boiled oil to the brick walls with a large paint or similar brush. Dry weather should be chosen for this coating or coatings, and preferably a sunny day, when the walls will have been warmed by the sun.

Hot tar and melted pitch have been employed for the same purpose, in the same manner, and often to improve the appearance of the wall crushed shells or clean sand is thrown on to the tarred surface before it has set hard.

Treatment of Brickwork

Another method that has been tried is to give the brickwork a coat of soft soap, followed by a coat of alum. There are also fluids specially made for the purpose of filling the pores or voids in the bricks and so stopping their porosity.

Lack of proper maintenance forms the sixth cause of dampness in buildings and is unhappily the most common of all. The ways in which slates or tiles get cracked or broken are countless. Workmen repairing or renewing glass in skylights, cleaning out gutters, telephone linesmen, are all responsible for such breakages.

It is not, however, only by cracked or broken slates that rain water is let into the most vulnerable part of a building—the roof; it is sometimes caused by an absence of proper lap in the slating in the first place. The insufficiency of lap may not be all over the surface of the roof, and even if it is it may not be necessary to strip the lot, but rather, as a trial, it would be best to strip a patch about 4 ft. super. around where the water is penetrating and to give an extra lap to the tiles or slates if able to do so, or pieces of zinc can be inserted between the slates, pushed up as far as the nails will allow, but showing below the edge of the slate.

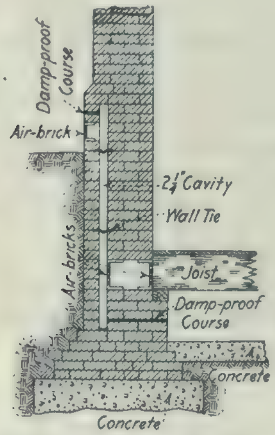


Fig. 11—An Example of Hollow Wall and Method of Treatment

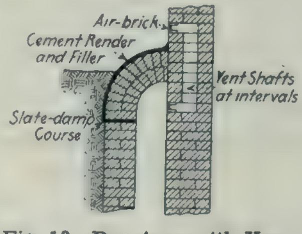


Fig. 12—Dry Area with Ventilation Shafts

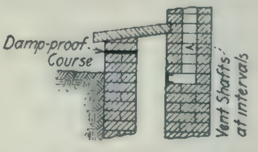


Fig. 13—Variation of Dry Area Shown in Previous Figure

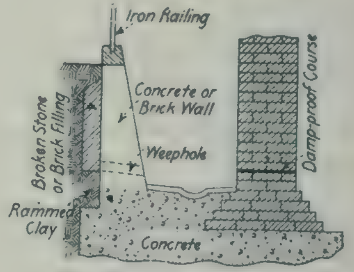


Fig. 14—An Open Area

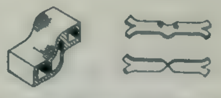


Fig. 15—Types of Ties for Hollow Walls

The Prevention of Dampness in Buildings.

Slaters may vary the lap, and they frequently do do so. Starting with the specified lap at the bottom, they gain the confidence of the clerk of works at the outset, and he is perhaps thereby induced not to pay the strictest attention to the slating work, and is consequently 'diddled" by loss of lap higher up the roof. However, the fault is not as bad as it could be, as if there is to be any change in the lap it is more necessary to have a larger one at the bottom than at the top of the roof, as the greatest volume of water collects at the former end.

Another cause of water finding its way through a slated roof is that the undereaves course is often too narrow, leaving a space instead of giving a lap, and as this is the lowest end of the roof, where the water collects in larger quantities, and where, consequently, the best lap is needed, rain soon finds its way through, but instead of plastered ceilings indicating the leakage the water soaks into the brickwork, and appears soon after in stains on the paper of the walls of the room.

Cause of Leaky Roofs

Often roofs become leaky by reason of the timbers of the roof settling, or by insufficiency of strength to support the roof covering and workmen at times of repair or the additional weight of snow, at other times. In such cases the roof should be strengthened by struting or firring it up.

The use of narrow strips of slate held, often, in position by one nail (two being impossible in the width) instead of using slate and a half or double slates is a cause of leaks in roofs, the small strips frequently getting displaced.

The careless or wilful boiling of leadwork in hips and valleys may lead to drops of water entering the roof, as also the use of slates holed incorrectly and reversed end for end.

On zinc or lead flats rain often drives or is drawn by capillary attraction over badly constructed rolls. The cloak of the lead covering of a roll should always be on the opposite side to that of the prevailing winds or rains. If flats are liable to be much walked on battens should be placed on them after the manner of snow gratings, and the same precaution should be adopted in slated roofs by providing cat or duck-ladders for access to the various parts of the roofs.

Other Causes of Dampness

Other causes of dampness are leaky or choked-up gutters. Both defects are heralded by falling or running water, and there is no excuse for gutters remaining in their bad condition long enough to cause real dampness to the walls. In searching lead gutters for defects, it is necessary to wipe the inside surface dry to find the crack, which will generally be noticed by water oozing from it.

Other items in a building requiring periodical inspection to avoid dampness entering are skylights, the timbers and putty of which rot with time unless properly coated with paint at regular intervals; and, lastly, it is necessary to keep all drains in good and clean working order.

The Qualities of Sheet Asphalt*

By George Norton†

WITHIN the past few years certain changes have occurred in traffic conditions which have largely eliminated one former standard road construction and it is well to look forward to the effect of these changes upon sheet asphalt through the introduction of heavy motor traffic. The truck with wheel load of 5,000 lbs. and upwards is now common on such pavements. For a pavement now laid which is to endure at least 20 years in the future, wheel loads of 10,000 lbs. or more may reasonably be expected. To meet these conditions there must be sufficient base to carry the load, sufficient tensile strength in the surface to withstand the tractive stresses and all possible adhesion or resistance between top and base to prevent relative movement.

The notes here presented are from experience in the maintenance of asphalt in Buffalo, N.Y.

The first sheet asphalt was there laid in 1878 and more or less has been laid every year since then. About five and one-half million yards have been laid of which about four and one-third million remain. The oldest in service is 9,000 yards laid in 1881 and 26,000 in 1882. About two million yards are 20 years old or more. An average life of at least 21 years is expected. Much of this pavement was laid on 6 inches of natural cement concrete for a base. On some of these streets there are now appearing small circular depressions without rupture of surface. It is assumed that these are due to a breaking down of the base by heavy traffic loads. These will undoubtedly be followed by a corresponding break in the surface. Under this assumption of cause and effect, this base is not sufficient. This 6 inches of natural cement concrete may be equal in carrying strength to 4 or 5 inches of Portland cement concrete, and such may therefore be assumed as of doubtful strength for a satisfactory foundation.

Many English cities are now using from 8 to 10 inches and even 12 inches of concrete for pavement base. This change has arisen from their earlier and more extensive experience with heavy motor traffic.

In the large cities it is also necessary to route heavier loads up to 30 or 40 tons over some streets. At present we use a 6-in. Portland cement base on all pavements, but this will now be increased to 8 ins. on certain heavy traffic streets.

No base should be expected to hold over extended settlements in the underlying soil, but should not shear down over small depressions or soft places.

If we assume the circumference of one of the above noted pothole depressions as 30 inches in a 6-inch base there would be 180 sq. ins. in shear. At the common assumption of 60 lbs. per sq. in. for concrete shear, the safe working load would be 10,800 lbs., or a safe strength for motor truck loads but not for occasional loads of 15,000 or 20,000 lbs. per wheel.

With a satisfactory base provided, the strength of the top must be considered. With a motor developing 60 h.p. at 10 ft. per second, the tractive effort on each of two wheels would be 1,650 lbs. If this be distributed over 8 inches of wheel face there is a tensile stress of 200 lbs. per lin. in. of tire transferred to the pavement surface. If this be resisted by but one inch in depth of surface there is a stress of 200 lbs. per sq. in. within the asphalt surface. Will it always stand it? With a plastic top mixture there will undoubtedly be some surface displacement; with a hard mixture or in cold weather may not a thin top be ruptured? These are only offered as suggestive questions to those who have inclined toward a thin surface, or for the possible effect upon surface repairs where new material in a thin layer may not be thoroughly welded to the underlying material.

The Binder Course

This question of surface movement under traffic naturally leads to consideration of the binder course. What is here said may be considered as hearsay in accepted asphalt practice. Buffalo has continued to use the open binder although the close binder is most generally recommended and used. We have continued the use of open binder after full and conservative consideration that there are yet sufficient sound theoretical reasons only to be set aside by proved results. The main function of a binder course, as the name implies, is to connect the wearing surface with the base. Another function may be considered as that of protecting the surface from moisture in or upon the base. No material adhesion of any binder to a concrete base may be expected unless possibly through an applied paint course. With an open binder thoroughly rolled in a thin layer the sharp-edged pieces of stone must be forced into all inequalities of the concrete base and to a greater extent than if partially supported by a matrix. The topping when rolled on this open binder is forced down and into the interstices from ½ to ¾ in., thus forming an asphaltic concrete having much stability and integral with the topping.

An argument in favor of the close binder is that it resists disturbance during the laying of the top and may even be safely used for some light traffic. But this very advantage introduces the well known difficulty of making proper adhesion where the surfaces are smooth and have dust and increases the danger of cleavage or movement along the joint plane. For resistance against lateral forces there appears a material advantage for open binder into which the surface mixture may be so forced as to obtain positive bond.

Another possible advantage of the open binder is that it provides a small but distinct drainage course for water passing the surface at car tracks or through breaks.

The points here intended to be emphasized are that the standard sheet asphalt is a paving material having excellent resistance to wear when properly supported. This support must be not only vertical by provision of a stable base, but lateral by a sufficient thickness within itself to withstand tensile traffic stresses without tearing and having continuity to transfer these stresses to the base in the most direct manner. Unless these supports are fully provided this pavement can not successfully meet the increased traffic requirements most evident for the future.

---

*Paper presented at the tenth annual convention of the American Road Builders' Association, Philadelphia, Pa., Dec. 9-12, 1913.

†Deputy Engineer Commissioner, Buffalo, N.Y.

Surface finish for concrete was given attention by the Board of Water Supply of the City of New York in connection with bridge construction on the Catskill aqueduct, and of several methods examined for securing even, clean textures the use of selected aggregate of pink granite for mortar facing was successful in special cases, according to the board's annual report. The mixture was poured by the aid of a sheet-iron diaphragm, moved as the backing was poured, the facing and backing being thus placed as a monolith. Experiments showed that the most practical ways of treating concrete surfaces were by pneumatic hammers and by sandblasts.

From the Saskatchewan Capital

Correspondence of the Contract Record

REGINA was the scene of active constructional development last year, despite the financial stringency which obtained during the closing months. While the building permits amounted only to $6,302,945, a great many structures were erected for which permits were taken out in 1912. Among the latter were the G. T. P. hotel building at a cost of $1,000,000, the McCallum, Hill & Company building, estimated to cost $500,000, and the Canada Life Assurance Company's new six-storey building, all of which have been described at various times in the Contract Record.

Among the buildings of more than passing interest erected last year were the Normal School, designed by Messrs. Storey & Van Egmond and built at a cost of $250,000, and the new Roman Catholic Cathedral, which cost over $200,000. Another building of note was the Telephone Exchange Building, the erection of which entailed an expenditure of $75,000. It speaks well for the general business development of both Regina and the province that during 1913 the space occupied by departmental stores increased three-fold. In this field the most noteworthy addition was the Sherwood departmental store, erected at a cost of $420,000. Last year also witnessed an extensive addition to Regina's pioneer departmental store, that of the R. H. Williams Company.

The new R.C. Cathedral at Regina.

Mention has only been made of a few of the buildings deserving of note. There were a number of structures for the School Trustees; an addition to the Collegiate Institute, costing $100,000; a new Provincial Jail, costing $250,000, and the arena, built at a cost of $150,000; but enough has been said to show that the constructional development of Regina is proceeding satisfactorily and that the city is not located in a zone of depression.

It is of passing interest to mention that Regina is one of the few Canadian cities which showed an increase in bank clearings last year, the figures being $132,087,457, as compared with $115,727,647 for 1912.

The building permits issued in the city of Toronto last year amounted to $27,038,624, thus practically tying with the total for 1912, which was $27,401,761. Last month's returns were $1,448,768, compared with $1,936,685 for December, 1912. The number of permits issued in 1913 was 9,084 and in the preceding year 10,217.

The report of the delegates appointed by the British Board of Trade to the sixth Congress of the International Association for Testing Materials, at New York last year, has recently been issued. The delegates report that on all points which appeared important to the British representatives the decisions arrived at by the Congress were satisfactory to them. The report asserts that there is general consent that if international specifications for iron, steel and cement could be agreed upon, advantage would result. The delegates make the following recommendations for the consideration of the Board of Trade:—(1) That his Majesty's Government recognize the International Association for Testing Materials by continuing to appoint delegates to the periodical Congresses, with instructions as to their duties; (2) that a subvention to the funds of the Association should be made either directly or through the departments interested in the work of the Association; and (3) that should the Congress meet in London in 1918, his Majesty's Government should accord the Congress official recognition.

Normal School, Regina, erected at a cost of $250,000. Architects, Messrs. Storey & Van Egmond.

Correct and Incorrect Methods of Factory Lighting

By G. H. Stickney

THE economic value of good illumination, aside from accident prevention, is evident in the greater facility with which an employee can work under good illumination and the greater accuracy with which gauges can be read and tools can be set. One large manufacturer, on investigating his lighting conditions, found certain departments in which the operatives were practically idle for about an hour a day during the winter months, solely on account of darkness. Good artificial illumination can be furnished in such a factory for eight hours a day at a cost equivalent to about five minutes of the time of the workmen benefited. This illustrates the extravagance of poor lighting. For a great variety of conditions good illumination reduces the manufacturing cost by increasing production, raising the quality of workmanship and reducing the number of defective parts and "seconds."

Accident Prevention

The phase of accident prevention is illustrated in the case of the foundry or other shop where cranes or other powerful machinery are in operation. The likelihood of crane and elevator accidents is greatly reduced with proper lighting. In the foundries and yards of a plant it is practically impossible to eliminate irregularities under foot. If not illuminated, these may readily cause falls, with resulting injuries; and in foundries where molten metal is carried and hot metal abounds they may often cause serious burns. Even though guarded to the fullest extent, powerful machinery presents a menace unless the operatives are given an opportunity to see and thus avoid the danger points.

As to the preservation of the eyesight, there are many manufacturing operations which cannot be carried on without accurate visual inspection. Some of these produce considerable strain even under good illumination, and to require their performance under poor illumination is certain to result in more or less rapid impairment of vision.

Undoubtedly a higher intensity of illumination is needed in most workrooms, but there are other features of equal and sometimes greater importance. The minimum intensity acceptable generally depends upon the reflecting power of the surfaces to be seen, the fineness of the detail to be observed, the time of observation and the closeness of application. Unless glare be introduced, a higher intensity of light is rarely objectionable, except from the standpoint of cost. The gain secured by the increase of intensity is not proportional to the intensity, and there is a point beyond which the gain would not warrant the additional cost.

The most common defect in lighting is excessive glare and absence of diffusion. Glare may emanate directly from the light source or be reflected to the eye by a glossy surface; it can also be caused wherever excessive contract of intensity appears in adjacent fields of vision. The dazzling effect is unpleasant and interferes with seeing. Under continued exposure eyestrain and even permanent injury to the eye may result. An unshielded light hung over a machine is a common source of eye fatigue. The glare may not be so evident on first glance, but when the workman's eyes have been subjected to such light for a long time discomfort and inability to see result.

Use of Reflectors

The workman frequently complains of insufficient light when in reality the intensity may be higher than is required for the work. In case an attempt is made to correct this by installing a larger light, the workman's eyes are subjected to a still more severe strain. The proper correction should be to shield the light by means of a proper reflector. As such a reflector would tend to direct more of the light upon the work, the working intensity would be increased; hence in many cases it may be possible to reduce the size of the lamp, or relocate it so as to enlarge the area illuminated.

When a light cannot be removed entirely from the field of vision its brilliancy should be reduced by means of a diffusing globe or reflector so as to increase the apparent size of the light source and reduce the contract between it and the background and the sharpness of shadows in the illumination.

Glare received from specular reflection of glazed paper, desk tops or polished metal often induces eye trouble, headache, and other indispositions, though the sufferers may not be aware of the cause. The remedy is to change the relative positions so that the reflected light is kept out of the eyes as much as possible and to enlarge the dimensions of the light source.

Proper Distribution

Another defect commonly found in industrial lighting is improper distribution. This may be due to too wide a spacing of lighting units. Under this condition some parts of the room are insufficiently lighted, while other parts may have more light than is necessary.

Improper direction of light may illuminate the wrong side of the machine, leaving the important parts in shadow. If the bright parts are near the shaded ones, whatever illumination may fall upon the shaded portion is rendered less effective by contrast.

Unsteady or flickering illumination is always objectionable. Such variation should always be avoided, whether caused by the units themselves or by the light passing through such things as moving wheels.

Good illumination cannot be prescribed without knowledge of the use to which it is to be put. In order properly to plan the lighting of a factory one should be familiar with the processes employed, the arrangement of machinery and work tables and the quality of product manufactured. Experience gained in well-lighted factories should be utilized in planning lighting installations.

The Grand Trunk and Can. Pacific railways have effected an agreement regarding the building of the new Union Station at Toronto. Mr. Drayton, Chairman of the Dominion Railway Board, is expected to issue an order requiring the work to be proceeded with at once.

The York County Highway Commissioners, in their programme for the current year, are planning a comprehensive scheme embracing all the main roads in the province. They will seek to compel the railways and owners of self-propelling vehicles to pay a considerable part of the cost of road maintenance. The commissioners believe that the provincial government should assume responsibility for maintenance of all the leading roads serving large centres of population, while highways connecting rural municipalities for county purposes should be maintained by the county. A substantial Dominion Government grant is urged.

Engineering Responsibilities and Lay Administration

That many readers take a vital interest in the suggestions put forward in the editorial article published under the above heading in our issue of January 14 is evidenced in the letters reproduced below. To facilitate a perusal of these letters on the part of those who did not read the editorial article in question, it may be well to say that our discussion centred around Montreal's unfortunate experience with its conduit, a break in which shut off the water supply for several days. The pivotal idea of the article was to direct attention to the unsatisfactory results which are obtained from the final direction of engineering matters by incompetent politicians. The presentation of this subject editorially was designed to originate discussion—with what measure of success the communications published in this issue will indicate. Many valuable ideas have been brought out in these letters, and it is to be hoped that the time and thought expended upon their preparation will not be in vain. A discussion of this kind has a well-defined educational value, and in stimulating thought on the part of those identified with municipal engineering it furnishes them with a most effective means of maintaining their proper status in the community and upholding their reputation at times when public criticism runs wild. It will be noticed that the commission form of government is favored strongly by several writers, notably City Engineer Macallum, the kernel of whose contentions is contained in the heading below which his letter is published. A careful analysis of the whole subject is made by Mr. John T. Farmer, of Montreal, whose ideals of civic administration are fulfilled in the government of a number of representative cities of the old land. A forcible presentation of the argument in favor of a smaller governing body comprising a centralized, specialized authority is made by Paul Chomedey. "An English Civil Engineer" holds the opinion that much of the trouble in municipal engineering in Canada is attributable to the fact that this branch of the profession has no organization. "Mekanikos" believes that an effective remedial measure would be the establishment of a Department of Municipal Administration —a suggestion which, in our opinion, has much to commend it.

Councils Usually Controlled by Three or Four. Why Not, Then, a Commission?

Hamilton, Jan. 20, 1914.

Editor Contract Record:

The seal of approval from a city's administration should mean something. If not, why should it be necessary? It is usually assumed that an "approval" is given by those familiar with a subject. If an approval of such be given it is equivalent to an endorsement. If not, what use is it, except to show that a matter has been before a council meeting?

Referring to the Montreal conduit collapse, I understand that the engineer has letters to show that he recommended a duplicate conduit, but that the council, in their wisdom, thought that only one was necessary. Even under these circumstances it may be assumed that though the council took the responsibility it will not take it now but will climb quickly out of the way, so that there may be no obstruction in getting a good shot at the engineer.

When an accident such as the above has occurred and the repairs must be made hurriedly, it often happens that the best means are not adopted. An engineer carrying out any particular construction usually finds that if he were to do it over again he would probably carry it out (in at least some details) in a different manner. For this reason Mr. Phelps Johnson's criticism is very much more likely to be fair than that of Professor Brown, of McGill, especially when you take into consideration the haste with which a decision on the method of re-construction will be carried out.

In Toronto there have been submitted two reports on the development of the water-works—one by a Commission and the other by the City Engineer's staff. How is the council, as constituted at present, able or competent to pass on the relative merits of the two schemes? Is it not probable that the merits of each case will not be carefully considered and that the council will either follow blindly one or other of the schemes or shelve the matter to some remote date, if possiblue?

The usual council is generally led by three or four men more or less familiar with city business. These men carry along the majority of the members, who are seldom familiar with most of the items on the list of business at the council meetings, unless it directly affects something in which they are personally interested. The votes of these men count, however, and on a subject of little personal interest, or lack of understanding to them, they may assist in carrying through some measure that is detrimental to the city at large.

Since the council is controlled usually by three or four of its members, it might as well be carried on by that number. Until the public and press, however, are trained to municipal responsibility far beyond the present state, it is difficult to see how any Commission stronger than the usual Board of Control is likely to be appointed, and until such time I see little hope of betterment in civic administration. If the candidates for such a Commission could be limited to men possessing certain qualifications, it would assist materially in obtaining a Commission that would, at least, commence business with a basis of special individual training to work upon.

Faithfully yours,

A. F. Macallum,
City Engineer.

Suggested Department of Municipal Administration

Editor Contract Record:

While arguing in support of a better system of municipal government, I have been faced with the answer that it is not possible to standardize civic administration, but that each municipally must be dealt with distinctly according to its individual needs. That may be so, but when we reduce the facts to a common-sense, material basis of dollars and cents, he must be a very complacent individual indeed who would bolster up the system now generally in vogue. Eliminate all big cities for the moment and consider an average town of, say, 10,000 population. The assessable value of such a corporation would be approximately three and a half million dollars, and the money actually received annually by taxes would be about $150,000. This money is turned over to ten or a dozen men, for the most part store-keepers or workmen—excellent men in their sphere no doubt, but too often wholly ignorant of financial or technical matters—who are somehow considered sufficiently competent to devise and advise ways and means of administering the money in their charge and all the purposes the money can command. To their credit be it said that their intentions are almost always good, and in the majority of cases the honesty of the men is beyond question, but can you imagine any company promoter, or stock jobber, trying to promote the welfare of a private company capitalized at three and a half million dollars and with an annual expenditure of $150,000, with its directorate consisting of men of the calibre and status mentioned? He would need to be a very plausible speaker to convince any possible stockholder that his investment would be worth more than blank white paper. It may not be possible to standardize municipal government beyond that already done by the several municipal acts, but, to my mind, there should be a Department of Municipal Administration in both federal and provincial cabinets. Systems of inspection of all municipal departments could then be established.

The different cities and towns could be grouped and classified according to a certain standard. All officials should at least comply with a certain standard set by the Government and each appointment should be made on merit along the lines laid down by a Civil Service Commission. I believe that this would bring about the methodical operation of municipal affairs, for the system of inspection would insure the regularity of all accounts and records, while the standard required for officials would mean competency on the part of the individual. The calling for tenders and letting of contracts would be done according ao a standard set or approved, copies of specifications would be filed, and a Commission of Inquiry could deal with extraordinary phases of work. Then in cases of dispute it should not be difficult to touch the spot and indicate where discrepancies had appeared, poor judgment had been shown or wasteful expenditure had taken place.

Yours truly,
"Mekanikos."

Crying Need for Executives of Higher Calibre

Montreal, Jan. 21, 1914.

Editor Contract Record:

Your editorial on the subject of Engineering Responsibilities appears to be a temperate and well-considered reflection on the circumstances surrounding the recent failure of the water supply of Montreal.

There is always a tendency, on the occurrence of any such calamity vitally affecting the welfare of the general public, to rush into a hysteria of criticism and denunciation of the nearest and most obvious causes of the misadventure. Such hysteria is usually fomented and encouraged by the sensational press—as in the present instance—and in the heat and indignation of the moment many things are printed and repeated from mouth to mouth that would not be said at all, or would be expressed more sympathetically, after due consideration. Such hysterical outbursts in the social as well as the physical organism have no curative value whatever: they are simply an evidence of weakness and leave a greater weakness behind them.

Assuming as an axiom that there is no such thing as an accident in Nature, and that for every event a cause can be found if it can be traced, then the responsibility for the recent disaster, in my opinion, is to be laid at the door of every citizen who has or should have taken part in the administration of the city during the last ten or fifteen years. It is very easy to lay the blame for such an occurrence on the official immediately responsible, but it must be remembered that every official is bound and limited by circumstances beyond his control and that the best he can do is to strive to overcome the difficulties imposed by the limitations with which he is surrounded.

In a rapidly developing country, it is admittedly one of the most serious problems to find ways and means to carry out the projects that are continually pressing for a solution. In many cases it is necessary to apply a solution which is felt to be incomplete but at the same time the best available. We are in the position of an army waging a long-drawn-out fight with superior forces, our hope of success being in attacks in which we concentrate all our resources in the main line of offence, leaving no second line of defence to fall back upon in case of a reverse. Such a policy may have been—and may still be at times—a necessity, but there is reason to fear that we have a tendency to make it a habit, whether necessary or not.

It is to be feared that we have still a good deal to develop in the way of true public spirit in this country. We can point to palatial homes and places and means of amusement, and we surround ourselves with every personal luxury, according to our means—probably to a greater extent than any other community on the globe—but when it comes to our public administration we do not show the same enthusiasm. Montreal, in population and wealth, now ranks as one of the great cities of the world, but its civic administration is not on a par with a third-rate European town. A city which boasts that its assessed valuation, apart from actual construction carried out, increases something like one hundred million dollars a year, should certainly be able to lay aside sufficient to provide itself with the ordinary equipment of a well-ordered urban community. Instead, the various departments show a similar story of emasculation and insufficiency. The waterworks, an abundant revenue producer for the city, has been notoriously starved as regards new equipment and up-keep. The police force has been shown to be far below the accepted modern standards, numerically, in spite of the fact that the development of crime among certain classes of immigrants indicates the demand for a strong administration of justice. The roadways of the city are a by-word wherever they are known, and recent improvements in dealing with this department have been made the object of a determined attack by self-interested parties, which only called forth a half-hearted and ineffectual remonstrance on the part of the general body of the citizens. The important questions of the disposal of sewage and garbage have only been taken up in the most elementary way. Less essential features of city improvement, such as insanitary areas, the provision of park ways, public library, music hall, street lavatories, public baths, etc., have hardly been touched.

The reason of all this is well known. The system of administration which came to an end with the Cannon Commission of Investigation was shown to be thoroughly inefficient, wasteful and generally rotten. Its effect was the burdening of the city with a heavy municipal debt, with little to show for it, which at the present day absorbs roughly one-half of the available revenue. It is now generally admitted by all unprejudiced observers that the modified system of directing the city's affairs by a Board of Commissioners has been a decided step in the direction of improvement. In my opinion, the lesson to be taken from the water famine is not to cry out for the demolition of the existing form of city government and the substitution of new and radical experiments, but to impress on all citizens who have the welfare of the city at heart the necessity of their giving time and attention to the study of administrative problems with a view to strengthening and reinforcing whatever is good, and weeding out and revising the elements that are useless or harmful.

The form of government by commissioners seems to have justified itself as the best scheme of administration yet devised, judging from its widespread adoption. In order to secure the best service, it would appear to be desirable—besides making the renumeration commensurate with the demands of such a position, to make the term of service of such duration as to make it worth while for a man of the proper calibre to offer himself, realizing that it means the severance of other important connections and interests that cannot be quickly resumed. For a Board of four Commissioners a term of eight years is suggested as too long, and the individual members should be elected or appointed at intervals of two years, so as to secure continuity of action. Then with a salary of $10,000 to $15,000 per annum it should be possible to secure men of the same calibre as those who are given control of the affairs of railways and large commercial enterprises. This is what the situation demands. Whether, in addition, there should be a secondary body of elected local representatives—such as the present council, is rather an open question. Recent events in Montreal have rather pointed otherwise, but still it must be remembered that the existing system has only been on trial for a comparatively short time, and it is impossible to eradicate at once the evils of a preceding regime. On the whole, the system of aldermanic representation of sections of the city has much to recommend it and in my opinion the trial should be continued for a reasonable time. It affords a wholesome check on the actions of commissioners, who must necessarily be invested with wide powers, and it gives the general body of electors a direct voice in the conduct of affairs—which they must have in some form. The evil has been that the dual system has resulted in dissensions and delays, and has tended to impede action. This, it is to be hoped, will correct itself in time by the good sense of the general body in refusing their support to individuals who have demonstrated that their only aptitude is for destructive criticism and obstruction; if it does not, then it will be necessary to cast about for another remedy.

So much for the administrative functions. As regards the technical department of the civic service, it is evident that all positions must be freed from patronage. The scope and responsibilities of each position should be defined and the indivduals given a free hand in the exercise of their duties, untrammelled by political considerations. Improvement has been effected in Montreal in these very directions, and much may be done along the same line.

It is easy to condemn a responsible official for any failure in his department. At the same time there may be many extenuating circumstances. Looking round among the various municipalities in Canada, one finds that in the last few years there has not been an increase in the personnel of the technical staffs in municipal employ commensurate with the vastly increased amount of work and responsibilities they have been called upon to undertake. This must have led to great pressure on those in charge, and this condition is one that must inevitably lead to oversights and omissions, consequent imperfections of work, and occasional breakdowns. It would appear timely to take this occasion to put in a strong plea, in Montreal and elsewhere, for the adequate manning of the various technical departments with men of proved ability and value—men whose services should be adequately recompensed and whose conditions of work should be made as favorable as possible.

These may be considered rather high—and perhaps impossible—ideals. Still they include nothing that is not to be found in the representative well-governed cities of the Old Country, and they should be equally realizable here. Permanent improvement can only be reached by aiming at an ultimate goal and keeping it steadily in view—not by hasty and spasdomic action, which, only too frequently, simply introduces unforeseen evils in place of those it is sought to remove.

Yours truly,
John T. Farmer.

Is the Municipal Engineer Holding His Own?

Editor Contract Record:

The editorial article, "Engineering Responsibilities and Lay Administration," published in your issue of January 14 was interesting to me because it strengthened an impression which I have been forming for some time, viz., that so little is done for the municipal engineering profession in Canada, and so scurvy is the treatment of men holding office under municipalities, that those of marked ability generally find their way into the service of corporations either here or in the United States. As you know, in England we have the Institution of Municipal Engineers, and other bodies, whose sole aim it is to improve the conditions under which the municipal engineer works. The Institution of Municipal Engineers has taken a decided stand against the over-ruling of "ignorant politicians," which seems to cause you such concern. It has inaugurated a mutual defence scheme consisting of a fund which is at the service of any member who considers that he has been treated unjustly and dishonorably and who may wish to defend his reputation. Your municipal engineer does not enjoy the status that he should, neither does he receive sufficient recompense for his work, except in the case of a mere handful of appointments. Perhaps better conditions will obtain when municipal engineers in Canada have an organization of their own.

What the engineer wants is more influence, a more prominent place in the community and more substantial regard for his opinions.

Is Canada getting the right men into the profession? Is the average engineer equipped, technically and otherwise, to hold his own?

Yours very truly,
"An English Civil Engineer."

Type of Administrator the Factor, not the Form of Government

Editor Contract Record:

Your article, "Engineering Responsibilities and Lay Administration," brings up several questions of the utmost importance to municipal engineers. In most Canadian cities, the engineering department is under the direct control of a Board of Works, or a Board of Control, which, in turn, is responsible to the City Council. If we examine the personnel of any given Board, how many men will we find qualified by their training, either technically or practically, to pass upon the work of the engineer? What does a dentist, a lawyer, or a brick-layer know about the technical difficulties encountered in a city engineer's daily work?

When the engineer recommends a certain work as being required he has to look to the Board to furnish the funds necessary to carry out that work, and how often it happens that, if the recommendation be approved, the Board in its wisdom will make suggestions (commands) which will perhaps impair the efficiency or usefulness of the whole work—though perhaps a few dollars may be saved thereby. The engineer should try to combine the greatest efficiency with the least cost. The members of the Board generally look at the cost and try to cut it down regardless of anything else, thereby securing for themselves the title of "watch-dogs of the treasury" and the approval of the mass of the rate-payers.

The engineer seems to be considered as trying to spend as much of the people's money as he can, while he may not have nearly large enough an appropriation to carry on his work properly. If, however, his work is not well done, he very soon hears about it—both from the members of council and the press.

The engineer is supposed generally to advise the Council on matters relating to his department, but how often do we find his advice ignored and the Council taking an opposite stand, not because the advice is not good, but because carrying it out might affect a few votes.

The basic trouble appears to me to be an utter disregard of the qualifications of the men elected to administer the affairs of the ratepayers. I do not think the form of government is so much to blame. Any form of government when in the hands of qualified men will be reasonably good, though some forms may be more cumbersome to operate than others. I think that the simpler and more direct any organization or form of government is, the more chance there is of good results. Combine a simple controlling body with few members and the most honorable upright men of any community and we have the best form of government—but—until the majority of the voters wake up to what constitutes their best interests, we shall not get it.

The details of such a government would have to be worked out to fit conditions. In one city it might be necessary to have a highly-paid commission, while in a small place the honor of being a "Commissioner" might be considered pay enough.

From my experience I may say that the councils in the smaller cities seem to take more interest in their engineering department than those of the large cities. I also think that as a rule better men are elected to council in the smaller cities and towns.

Another point is that in most cities there is a change in the personnel of the council too often. The term is too long for an incompetent or dishonest man and too short for a competent, honest man. In other words the government is liable to change too often, with resulting bad effects.

Personally I am in favor of a small commission to control the affairs of a city, with modifications to suit local conditions.

It is the man that counts, however, not the form of government.

Yours truly,
"C. E."

A Centralized, Specialized Form of Government for Our Cities

Montreal, January 20, 1914.

Editor Contract Record:

I have read your editorial article, "Engineering Responsibilities and Lay Administration," which appeared in your issue of the 14th instant and I appreciate its direct application to conditions existing in Montreal—conditions which have been suddenly revealed to the people by a serious failure of the water supply system.

To provide adequate facilities to meet the rapid growth of a city is a very puzzling problem, and unless the administration is a very well-balanced business body it is prone to resort to expedients, sometimes entering upon schemes of comprehensive character and committing the city to large expenditures on works that have been studied but superficially by its departmental officers, aided probably by advice from some imported engineer, all of which if given honest study by a competent business body would have been considerably modified, or else never entered into at all.

On the other hand, the city may temporize by doing as little as possible in the way of carrying out a larger plan—merely adding here and there to its existing systems. As these systems were designed for smaller duty they are soon over-taxed and before long bring about a state of inefficiency in the whole.

Montreal has been guilty of both, and the reason why the city is in its present state is that it has endeavored to provide for its growth while being dominated by an inefficient governing body.

No business concern would spend its money so unwisely and to so little benefit to the shareholders as the city does. The sufferer is the taxpayer. If a board of directors did what the City Council and Board of Control have done and are doing, the shareholders would demand an explanation and find a remedy for the evil.

I do not say that Montreal is the only city that finds itself in this position. Montreal has grown with abnormal rapidity. The civic government has done what it thought best to meet this growth, but it has failed to accomplish what the citizens expect and are entitled to, and the only dividends the taxpayer gets are increases in his tax-bills to pay for work which proves, too late, to have been ineffective and much of it has to be done over again.

A good warning at a railway crossing is, "Stop! Look! Listen!" It would be a foolish person who would disregard the warning. Montreal is at a critical place where caution is necessary.

The late water-works disaster may prove to be a blessing in disguise. We are apt to harp upon it and talk of how the damages were repaired, and many a decent fellow has become an expert all at once and spoiled any good he might have done by declaring that he could have repaired the damage in so many hours. I have done emergency work in flowing water in zero weather, and I know what it means to work day and night. I have no word to say against the men who made these repairs. They did well. Dwelling on such details is useless. These events serve to call attention to a condition of affairs. Stop! Look! Listen!

As soon as the accident happens, one of the controllers is given an idea by a citizen and at once concludes that an emergency supply of water must be provided from the Lachine Canal, and the controllers at once apply to the Legislature for leave to borrow another million dollars for a second conduit.

While there is no need to waste time, there is no excuse for hysterics. As a citizen of Montreal I have to submit to anything that the present governing body may choose to do, and all I can say is that never to my knowledge have they followed a logical or business course, and present conditions prove it—not only in the Water-Works Department, but in many other branches, such as Roadways, Sewers, and even the Fire Department, of which we have reason to be proud, for if care is not exercised we shall soon find our alarm and signal system obsolete.

I have had to do with various councils, boards and governing bodies, and in thirty years' experience I have found that the larger the body the less individual interest is taken by the members of that body. Our governing body is too large. Our ward system tends to develop the petty politician seeking local benefits and ignoring the larger questions, or at least not considering them carefully. His thoughts are local and when he is called upon to give an intelligent opinion on a question of importance to the whole city, his training has rendered him incapable of giving an opinion of any value.

Such representatives (and ninety per cent. are of this class) when confronted with a serious problem fall back on a departmental head and get his report. Not being able to discuss the matter in a logical or business manner, the report is accepted. The money voted, the work is shoved through, and when done it is found inadequate in many cases—something was forgotten, not provided for.

The responsibility for failure must lie primarily with the council, as in the case of a business concern it would lie with the Board of Directors.

The council cannot hide behind their departmental head who advised them so often and they cannot shift responsibility. It was always in their power to get proper heads of departments. They can now make any change that may be desirable, and appoint better advisers, but the responsibility for what has happened must be theirs.

When I say that the responsibility is on the council, it follows that it is on **the System of Government by Council.**

It is useless to say that aldermen are dishonest. There are many ways of being dishonest. An honest alderman must admit that the present system is ineffective, and yet he clings to it because it is the acknowledged form of government; and he does the best he can, but he knows that he would not conduct his own business in the way the council conducts the business of the city.

A smaller governing body is the first requisite to good government. The whole city should be represented and local ward representation should be abolished. To my mind the governing body should consist of three able men, one of whom should be Chairman. This Board would be responsible for all administration and for all appointments, and the organization would hold each member of the city's staff directly responsible to it for performance of duties.

These three men should be carefully chosen from men of such high standing as our Superior Court Judges, and they should have the business knowledge of a Bank Manager. They should be paid good salaries—as much as a General Manager of a Bank, and far more than our Superior Court Judges. They should be appointed for life or good conduct, or at least for a term of five years, one retiring at a time so as to make the body continuous. All three should be under substantial bonds.

With a responsible governing body like this, we should all have confidence and feel that we had done our best to safeguard our own interests and benefit our city.

How is this change to be accomplished? By the moneyed class, the bankers, railway interests, the merchants, the insurance men? I think not. You must get the working man, the clerk, the younger element to understand that this will mean for them a fairer, better expenditure of the money they pay in taxes. This element is the real city—the poor man and the fairly well-to-do. These should be convinced of the wisdom of the change, and once convinced they will make the change quickly enough.

Some have tried to drag the race cry into this question. Race has nothing to do with the principle. All French-Canadians are as anxious for good government as English-Canadians, and they will work like brothers for any good cause.

Let them join in a heroic remedy for the present unbearable system. Let us destroy it and erect in its place a system such as I have outlined above. Now is the time to do it.

Very truly yours,

Paul Chomedey.

The estimates to be tabled in the Dominion Parliament will provide for improvements to the St. Lawrence route to the extent of a couple of million dollars. Fifteen high-power dredges will be at work next year, mainly between Montreal and Quebec, and two of them will be the new ones now under construction at Collingwood. The construction of what promises to be the largest dredge in the world will be tendered for in a few days. The dredge will have a lifting capacity of 1,500 tons of excavation an hour.

"Indian Village" Administration

Montreal, Jan. 22, 1911

Editor Contract Record:

I heartily agree with your views as expressed in your editorial, "Engineering Responsibilities and Lay Administration." Briefly I may state that I believe the muddling of engineering works in municipal engineering in Montreal and many other cities is due chiefly to the attempt to run large corporation affairs as if they were the affairs of a small Indian village. Every one of the tribe of meddlesome aldermen insists on imposing his views not only in the council chamber but in the field of engineering. The result is that an admirable staff of thoroughly competent engineers is driven to desperation and is so restricted that it cannot order a lead pencil without first explaining the reason and attempting to convince one ignoramus after another.

Given responsibility and authority, Canadian municipal engineers can be trusted to do the right thing, but hampered by the corrupt practices, of a most exasperating nature, which surround them, defeating every honest attempt at efficiency, they are merely machines, no more able to make the grade than a locomotive in the ditch.

Yours faithfully,

R. O. Sweezey.

The Montreal Conduit—Proposed Enquiry

Mr. G. Janin, chief engineer of the city of Montreal, who has been the subject of strong criticism over the break in the water conduit, has asked the Controllers to hold an enquiry. He writes: "The campaign to which the break of the conduit has given rise in the press—and against which, so far, I have had no opportunity to defend myself, tends to ruin my reputation and that of the engineers of the Water Department, while at the same time injuring the reputation of the leading members of the profession who have endorsed the improvements of the aqueduct as we had designed them. Until a decision is taken regarding the inquiry which the public outcry seems to require, my silence might give the impression that I am opposed to such a measure; on the contrary, I consider it to be in my interest and that of my associates that an inquiry be held without delay, in an impartial and thorough manner. Such is my belief and I am writing the Board of Commissioners mentioning my wishes concerning the matter." Mr. Janin is very ill as the result of his exertions supervising the repair of the conduit.

Mr. John R. Freeman, the New York expert engaged by a committee of citizens, has reported on the repair of the conduit. He recommends the plan which is now being carried out to strengthen the conduit and endorses the proposal for an emergency supply from the Lachine Canal. He says that the quickest and cheapest safeguard is a heavy, thick and deep deposit of broken rock placed directly upon the present earth bottom of the cut (water being first pumped out and the ice removed), this rip-rap to lie directly against the present earth slope and by its weight and support prevent further caving or sliding.

Power has been given by the Quebec Legislature to spend two million dollars on the waterworks system.

A Bill is also being promoted for the city of Montreal to take over the system of the Montreal Water and Power Company, a provisional agreement having been made between the directors and the Controllers. The question of price will have to be settled, and it is probable that the citizens will be asked to pass a by-law approving the purchase.

Ontario Reunion of McGill Science Graduates held in Toronto

ON the evening of Saturday, January 17, the Ontario graduates of the Faculty of Applied Science of McGill University, Montreal, held a reunion at the Engineers' Club of Toronto. The meeting was a particularly happy and successful function and was attended by over fifty. The guests of the evening were: Dr. Adams, Dean of the Faculty of Applied Science of McGill University; Dr. Galbraith, Dean of the same faculty at the University of Toronto, and Professors C. H. McLeod and N. N. Evans, of McGill University.

After a pleasing menu had been disposed of and the toast to the King had been duly honored, the chairman, Mr. Willis Chipman, in a happy speech welcomed the graduates and introduced the toast-master, Professor Evans, who discharged the duties of this office most capably. The toast list was as follows:

"Our Alma Mater," proposed by Mr. W. F. Ferrier, B.Sc., and responded to by Dr. F. D. Adams.

"Applied Science," proposed by Mr. J. G. G. Kerry, M.Sc., and responded to by Professor C. H. McLeod.

"Sister Universities," proposed by Major T. Harry Jones, and responded to by Dr. Galbraith.

In proposing "Our Alma Mater," Mr. Ferrier, in an enthusiastic speech, directed the attention of those present to the prominent positions held by graduates of McGill University and showed how their achievements had brought honor to their alma mater. Replying, Dr. Adams reviewed the history of the Engineering Faculty from the time of its formation, showing how it had grown from a small class back in the 60's to a world-renowned institution with the present large attendance of 580. In the early days there were few buildings and less facilities, but now the advantages offered by the Faculty placed McGill in the forefront of engineering schools. Curves had been prepared showing the attendance from 1880 and the rapid increase as shown graphically was very marked. An idea of the cosmopolitan nature of the student body might be gathered from the fact that forty different nations were represented at McGill. The graduates were distributed over the greater part of the inhabited sections of the world and everywhere the name of the University was being upheld by men who were forging ahead in their profession.

An important announcement made by Dr. Adams was that Sir Wm. MacDonald had donated a site of some twenty-seven acres for the erection of new buildings for the University, these to comprise residences, gymnasium and edifices for the various faculties.

Mr. J. G. G. Kerry, in proposing "Applied Science," dealt with the men who were graduates of this faculty, making interesting reference to the achievements of those who stood out most prominently. Professor McLeod's response was along much the same lines as Mr. Kerry's observations and was particularly well received, practically all of those present having sat under Professor McLeod at college.

In proposing the toast, "Sister Universities," Major Jones commented upon the good spirit which existed between the several colleges and expressed gratification in knowing that instead of a feeling of jealousy there was one of friendly rivalry—a feeling which tended to give the students a most efficient and successful training. Dr. Galbraith, who replied, spoke at some length on the proper education of the engineer. A great many people entertained the idea that an engineer should be a master of mathematics and the sciences—a theoretical expert, but this was an erroneous principle. The student should be grounded in the first principles of the sciences and shown how to apply them. In this way the future engineer would be able to grasp what was required for the solution of any particular problem and would know where to seek and how to apply the necessary knowledge and theory. The main theme of Dr. Galbraith's address was a common-sense, practical education for the engineer.

The toast list completed, Mr. Chipman called upon the assembly to honor the oldest engineering graduate present, Mr. Maurice Gaviller, who responded, giving some interesting reminisences of his experiences at McGill University in 1861-3. Mr. J. McEvoy then proposed the health of the toastmaster, Professor Evans, who replied with characteristic heartiness. Professor Evans' remarks were of particular interest in that they touched upon the work accomplished in connection with the Graduates' Society, an organization designed to keep track of the graduates and maintain a man's university connection by means of bulletins. It may be noted that the onus of the heavy duties involved in this work is borne by Professor Evans, who is honorary secretary. After the thanks of those present had been tendered to the committee in charge of arrangements by Mr. A. R. Davis, and acknowledged by Mr. J. R. Larmonth, a very pleasant evening came to an end. Mr. Willis Chipman came in for considerable congratulation as the proposer of the reunion and as one who had been particularly active in bringing the idea to a successful consummation.

The personnel of the committee was as follows: Mr. Willis Chipman, chairman; Messrs. W. F. Ferrier, J. McEvoy, A. L. Mudge, J. H. Larmonth, E. R. Clarke, H. G. Nicholls and M. J. McHenry (secretary).

Annual Meeting of Toronto Branch C.S.C.E.

THE annual meeting of the Toronto Branch of the Canadian Society of Civil Engineers was held in the lecture room of the Engineers' Club on January 21, under the presidency of Mr. E. A. James. The Secretary-Treasurer, Mr. A. B. Garrow, submitted a report which showed a cash balance of $877.50, a considerable portion of which is to be expended in the enlargement of the already extensive library belonging to the Branch.

The election of officers for the year resulted as follows: Mr. A. F. Stewart, Chairman; Mr. J. Galbraith, Jr., Secretary-Treasurer; Messrs. J. G. G. Kerry and C. H. Mitchell, and Prof. Gillespie, members of the executive committee.

Mr. Kerry was chosen to represent District 5 on the Nominating Committee of the Society. The meeting adjourned after tendering a vote of thanks to the retiring chairman.

Annual Meeting of the Canadian Society

The 28th annual meeting of the Canadian Society of Civil Engineers is now being held at Montreal. The dates of the meeting are January 27-29. It is the first time that a general convention has been held in the Society's new buildings on Mansfield street, Montreal. The retiring president of the society is Mr. Phelps Johnson, head of the St. Lawrence Bridge Company, and the president-elect is Mr. M. J. Butler, executive head of Messrs. Armstrong, Whitworth of Canada, Limited. Mr. Butler will be remembered as the former General Manager of the Dominion Steel Corporation and previously Deputy Minister and Chief Engineer of the Department of Railways and Canals of the Dominion Government. The nominees for vice-president are Mr. R. A. Ross, of Montreal, and Mr. A. F. Stewart, of Toronto.

Engineering Progress at Nanaimo, B. C.

DESPITE the money stringency and unsatisfactory labor conditions locally, which handicapped operations during the latter part of the year, 1913 witnessed great progress in the Works Department at Nanaimo, B.C., which is under the supervision of Mr. S. Barlow Bennett, City Engineer. A copy of Mr. Bennett's report, which has just reached us, contains much of interest in regard to the activities of the year at Nanaimo. One of the important undertakings of the year carried to successful completion was the construction of an 18-in. wooden water-main, together with the general improvement of the distribution system of the district. An illustrated description of this undertaking was published in our issue of December 24, 1913. The work entailed an expenditure of $22,514. The total length of 18-in. diameter pipe laid from No. 1 dam to the city was 10,800 ft., the pipe being supplied by the Dominion Wood Pipe Company, Limited, New Westminster, B.C.

In regard to the maintenance and operation of the water supply, Mr. Bennett deplores the waste of water and advises the installation of meters. In this connection Mr. Bennett's suggestion might be taken in conjunction with a reading of the article, "The Economics of the Water Meter," published in our last issue.

Mr. S. Barlow Bennett, City Engineer of Nanaimo, B. C.

In the department of street paving, Mr. Bennett's force was particularly active during 1914, plans, profiles and specifications having been prepared for upwards of 99,000 square yards of pavement. It is hoped that at an early date the paving of the important streets of the city will be an accomplished fact, actual operations not having been commenced last year owing mainly to unsatisfactory labor conditions. The prices submitted for paving were: 4-in. concrete base, with 2-in. asphaltic top, $185,753, and for 5-in. concrete base, with 2-in. asphaltic top, $200,258. The total mileage of sidewalks laid is 18.

The Newcastle townsite sewerage scheme, upon which operations were suspended during the winter of 1912 owing to heavy snow-falls, was re-commenced the latter part of January. The laying of an additional 5,000 ft. of vitrified earthenware pipe, together with 800 ft. of 12-in. cast-iron pipe for the outfall completed the system by the latter part of May. The total cost was approximately $16,000. Mr. Bennett regards the average cost of $1.48 a foot as very satisfactory taking into consideration local conditions.

During 1913, 10,100 ft. of sewers were laid. The total amount of sewers now laid at Nanaimo is 55,632 ft., or about 10.5 miles. The whole of the work undertaken by the Sewers Committee has been carried out by day labor.

Increased activity is noticed in the Building Department, which also comes under the supervision of the City Engineer. The preparation of a building by-law is recommended in Mr. Bennett's report.

An Amendment to the Saskatchewan Public Health Act

At the recent session of the Saskatchewan Legislative Assembly, there was passed an amendment which will prove of interest and advantage to municipalities in that province contemplating the establishment or extension of public health works and to engineers acting for such municipalities.

The Public Health Act of Saskatchewan is frequently referred to as providing perhaps the most advanced legislation in regard to waterworks, sewerage and sewage disposal control.

Prior to the passing of the amendment, the Act required that complete plans and specifications of all waterworks, sewerage or sewage disposal systems or extensions should be submitted to the Commissioner of Public Health and his certificate of approval obtained before any by-law for the purpose of raising money for such works could be submitted to the votes of the electors; and further, that no debentures would be valid if issued under any by-law passed in contravention of such requirements.

The Commissioner has received the hearty co-operation of the various municipalities in the administration of the Act, but he has noted that in some cases, particularly in the smaller towns, the preparation and submission of complete plans and specifications, previous to the passing of the by-law, was a matter which called for re-consideration, because of the following circumstances:

(1) A municipal council taking up office in January required some six weeks in which to formulate the constructional programme for the year. The engineer, on receiving his instructions, proceeded with the preparation of plans and specifications, which occupied at least two months. These plans and specifications were submitted to the Commissioner of Public Health during the month of April and assuming that they were satisfactory to the Commissioner, the by-law could not be voted upon until it had been advertised for three successive weeks. Thus the electors did not vote until about June 1st, and the necessary procedure following the passing of the by-law usually delayed the letting of contracts until the constructional season was far advanced.

(2) Consulting engineers engaged by municipalities of necessity had to incur considerable expenditure in rushing the preparation of detailed plans and specifications, for which remuneration was not forthcoming in many cases until the debentures were sold.

(3) There was a possibility of the by-law being opposed by a majority of the ratepayers, in which case the preparation of the details of the scheme meant unnecessary expense to the municipality.

The difficulties raised will be met by the new amendment, wherein it is required that a report, general plans and such information as may be required to allow of a general understanding of the proposed system or extension may be submitted and a provisional certificate issued by the Commissioner, which will be sufficient for the purposes of the by-law.

No debentures, however, will be valid until the complete plans and specifications of the system have been submitted and approved.

There will shortly be issued from the Bureau of Health regulations stating definitely what form the various plans and data necessary for the provisional and final certificates shall take.

Annual Meeting London Builders' Exchange

At the annual meeting of the Builders' Exchange of London, Ont., held under the presidency of Mr. L. H. Martyn in the rooms of the association in the Bank of Nova Scotia Building on Monday, January 19, the following officers were elected: President, Mr. T. R. Wright; First Vice-President, Mr. E. R. Dennis; Second Vice-President, Mr. A. Nobbs; Secretary-Treasurer, Mr. F. S. Barclay. Auditors: Messrs. J. Whittaker and E. Gerry. Board of Directors: Messrs. T. R. Wright, E. R. Dennis, A. Nobbs, L. H. Martyn, Geo. S. Gould, L. R. Folley, W. T. Pace, F. G. Tulett and Geo. H. Haney. The association made rapid strides in every department during the last twelve months and 1913 passed into history as the most successful year in the records of the Exchange.

Personal Mention

Mr. Isidore Feldman is going into architectural practice in new quarters at 44 Adelaide street west, Toronto.

Mr. H. A. Brazier, assistant city engineer of London, Ont., has returned from a short trip to the Old Country.

Mr. William H. Connell, Chief of the Bureau of Highways and Street Cleaning, Philadelphia, Pa., recently delivered an illustrated lecture, "Organization and Methods of Street Cleaning Departments" before the Graduate Students in Highway Engineering at Columbia University.

Sir William Willcocks, the English engineer who designed the Assouan Dam and who is in charge of British irrigation and drainage works in the East, will deliver an address on "River Regulation and Control in Antiquity" at the fourth National Drainage Congress at Savannah, Ga., April 22.

Mr. Charles H. Egleo, for nine years General Manager of the Ambursen Hydraulic Construction Company, in charge of their construction work, has just become connected with the Aberthaw Construction Company of Boston, and will have charge of all dam and reservoir work for this company.

Mr. P. B. McGinnis, who takes the place of Mr. W. B. Rawson as Construction Engineer for the Canada Cement Company, has taken up his duties at Medicine Hat. He has been connected with the company at Winnipeg and will have full charge of the construction work until the completion of the plant.

The Tuec Stationary Air-Cleaning System

From Mr. Jas. J. Martindale, Ontario representative for the TUEC stationary air-cleaning system, we have received a copy of an artistic, informative publication devoted to an explanation of the principles of the TUEC apparatus and an enumeration of its various applications.

The TUEC system has made rapid strides since its first introduction into Canada a few years ago. It has become famous by virtue of its sanitary character, its efficiency and durability, its simplicity of construction and its low operating cost. TUEC installations have been placed in some of the finest buildings of all types erected in recent years. These are illustrated in the booklet under discussion, complete sections being set apart for photographic reproductions of costly residences, private dwellings, churches, cathedrals, apartment and flat buildings, public buildings and educational institutions, hotels, commercial and office buildings, and so on. It is interesting to note that Canada figures prominently in some of the best of these installations.

The International Joint Commission heard arguments at Washington on January 13 against granting authority to the city of Winnipeg to obtain its water supply from the Lake of the Woods which has a water-shed of some twenty-six thousand square miles in the United States and the Dominion. Both the Canadian and United States governments have assented to the Winnipeg water project, but under the treaty the commission has the right to over-rule these decisions if it finds the plan detrimental to boundary waters or to the people residing near by. Objection was made to Winnipeg's request by representatives of the city of Kenora, at the mouth of the Lake of the Woods, on the ground that their municipal plant would be injured if Winnipeg were allowed to tap the lake. The commission have extended until February 24 the time for hearing arguments on the application of the Michigan Power Company to continue its diversion to the waters of St. Mary's River at Sault Ste. Marie.

New Motor Street Watering Carts

Messrs. Leyland Motors Limited, Leyland, Lancs., Eng., recently completed for the city of Nottingham two motor street-watering carts with interchangeable refuse bodies. One of these carts is shown in the accompanying illustration. These carts are wonderfully efficient and of an entirely new design. The water, instead of being spread by gravity over a width of road from twelve to fifteen feet, is delivered by pressure produced by placing a turbine pump between the tank and the nozzles. As a result, pressures can be obtained up to fifty pounds, and roads varying in width up to fifty feet can be watered. With separate nozzles, asphalt paving and wood block roads can be thoroughly scoured and washed. The pump can also be used for filling the tank from a river or canal, this being effected by an arrangement of valves. It is valuable as a means of first aid in the case of small fires as it will throw a jet of water to the top of a three-storey building and enough water is carried to put out a fire of considerable proportions. In case of emergency, this motor watering cart can be run at a speed of twenty miles an hour.

Type of motor street-watering cart used by the city of Nottingham.

In an article relating to constructional work at Port Arthur published in our issue of December 31 it was stated that quite a colony of "wooden" residences had sprung up at Ray Park. This was a typographical error and should have been rendered "modern." The error was pointed out to us by Mr. H. S. H. Goodier, Secretary of the Port Arthur Board of Trade, who states that since the publication of the article word has reached him of further prospective developments in Mariday Park, in which more than $600,000 will be spent on residence work in 1914. This sub-division is owned by Mr. J. J. Carrick, M.P.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The Elder Ebano Asphalt Company, Limited, Montreal, has declared a dividend of 6 per cent.

The Mines Branch of the Department of Mines has installed at Ottawa a modern and well-equipped laboratory for the purpose of experimental concentration and metallurgical tests with Canadian ores and minerals.

The Woodstock, Ont., Board of Works have decided to ask the council's permission to advertise for an engineer to take full charge of the city's streets and to combine the work of street commissioner with that of surveying and civil engineering.

A new sewerage system at Weston, Ont., is about to be completed, the only remaining work being a small portion of the storm sewer, which must be constructed over private property. The Resident Engineer, Mr. Hicks, is in charge of the work.

Plans for the new Gerrard street bridge, with a recommendation that the estimate of $382,000 be accepted, were submitted to the Toronto Board of Control recently by Mr. Harris, Commissioner of Works. This design would give a 66-foot width and carry 40-foot cars.

An interesting paper, "Sewage and Sewage Disposal," was read before members of the Port Arthur board of trade recently by Mr. L. M. Jones, city engineer. Mr. Jones dealt with the question of plans for sewers and drainage and discussed several suggested improvements for the city.

A deputation from the Toronto city council waited upon government ministers recently and urged the desirability of starting preliminary work on the various public buildings decided upon for Toronto. These works include the new Post Office, Customs House and harbor improvements.

A report from Fredericton, N.B., states that the Intercolonial Railway have made extensive development plans, which include the construction of a modern station at Fredericton. A freight warehouse, roundhouse, machine shops and yards are also to be built by the company.

The Toronto City Solicitor has obtained the approval of the Board of Control to sue a number of defaulting contractors for the difference between the price of the original contract and the cost of the new one in cases where they have declined to execute the contracts taken out.

It is predicted by architects in London, Ont., that building on a large scale will open up in that city during the spring. Work will be commenced on the new post office in the next few months and a rumor is current that a Toronto firm is contemplating the erection in that city of a new warehouse or a retail store.

The low-level pumping station at Montreal is to be fireproofed in order to comply with restrictions laid down by the fire underwriters. The floors of the buildings, which house a total pumping capacity of sixty million gallons daily, will be laid in concrete and a fire-wall be built on the west side of the boiler house.

A report from Ottawa announces that the government will erect a $300,000 building for the purpose of housing a first-class display of the natural products of the Dominion at the forthcoming Panama Exhibition. Each of the big Canadian railways will also erect a building for the accommodation of their individual exhibits.

The Canadian Connecticut Cotton Mills, Limited, has practically completed its large plant at Sherbrooke, Que., which is expected to be in operation early in February. The company will manufacture tire fabric exclusively and is said to have disposed of its entire output to four of the largest Canadian tire manufacturing companies.

A new highway, 224 miles long, connecting Augusta, Me., and the city of Quebec, is assured, according to an announcement by the State Highway Commission of Portland, Me. The Quebec government has appropriated $300,000 to build the road from Quebec to the Maine boundary, a distance of 93 miles, and the remaining 131 miles will be constructed by the State of Maine.

The specifications of the proposed dam on the St. Maurice River, P.Q., have been prepared by the Running Waters Commission. The object is to provide an even flow of water for industrial purposes, and make possible the development of a very large amount of horse-power. The dam is to be constructed above La Loutre Rapids, four miles above the mouth of the Wabane River, and will be 1,720 feet long.

The engineers of the city of Montreal are at work on a report which will recommend the immediate construction of subways and new surface lines in order to improve transportation facilities. According to information given out, the report will advise the construction of three subways, one running east and west, another north and south, and a third in the business section. The subways will allow for sewers and conduits to be laid in them.

The St. Agathe Lumber & Construction Company, Limited, incorporated recently by federal charter with a capital of $300,000, contemplate the erection of a factory at St. Agathe des Monts, Que., for the manufacture of cement products. They will also erect a plant for the production of lumber, doors, sash, flooring and other products. The officers of the concern are: president, Mr. L. E. Parent; vice-president, Mr. J. B. Reid; director, Mr. F. Forget; secretary-treasurer, Mr. E. Parent.

Now that the final draft of the proposed new building by-law for Hamilton is ready for adoption by the city council, objections are being raised on all sides, one of the most important being in regard to the provision requiring all buildings erected in the central part of the city to be of fireproof construction. At a meeting of the Board of Control at which the matter was discussed, the Mayor expressed the opinion that such a provision would about double the cost of building construction in that part of the city. The by-law is at present in the hands of the City Solicitor.

Announcement is made from Ottawa that contracts for the new public buildings at the capital will be awarded in the spring of 1915. The time for the reception of preliminary designs, which was originally fixed for January 2 of this year, has been extended to April 2. The new buildings are to be fireproof throughout, and will be designed to provide a superficial office area of 500,000 square feet. It is expected that the buildings will take two years and a half to complete, and the cost will run into millions. When these and the new Customs buildings on Sussex street are completed there will be a continuous line of government buildings for more than a mile.

The Dominion Government has cancelled the contract of Messrs. Connolly & Charleson, who were erecting new steamship berths at West St. John, N.B., and announces that other steps will be taken to hasten this work, in order that at least two more steamship berths may be available for use next winter. The Government is also considering a request of the city council that two steamship berths, each about eight hundred feet long be constructed on the east side of the harbour near its mouth and convenient to the large sugar refinery, on which construction work is now well advanced. More wharves are needed on the east side of the harbour to meet the growing demands of the traffic of the port, and if the Government regards the city's request favorably there will be great activity in construction work on both sides of the present harbour, in addition to the great work in progress in Courtenay Bay.

On the south side of the Gulf of St. Lawrence, the St. Lawrence Pulp & Lumber Corporation is erecting a big plant which when finished will represent an investment of close to a million dollars. There is an irregular group of buildings, mostly one-storey and measuring something like 900 by 200 feet in plan, forming a complete pulp mill for making high-grade bleached sulphite pulp, together with a digester building covering digesters reaching 160 feet above ground. All this is now being built by the Aberthaw Construction Company of Boston, and is to be finished by next September. The buildings have concrete exterior, the interior structure being largely of structural steel with yellow pine roofs. A private railroad is to supply the mill with logs from the extensive timber and pulp wood limits of the company, aggregating some 500 square miles. The Dominion Government has undertaken to develop a harbor for safe wharfage for ships up to 6,000 tons.

An agreement has been made between the St. John Railway Company and the municipal council for the extension of the company's line three miles to Coldbrook, where an industrial suburb is being developed. There is already an automobile factory at Coldbrook and arrangements have been completed to erect a nail factory. There is talk of a company establishing a shoe factory there, and the Coldbrook Realty and Development Company will continue its work of making a garden suburb. The street railway company has already undertaken to extend its line through East St. John, in the opposite direction from Coldbrook, to a point at Little River, just beyond the works at Courtenay Bay. During the present year, also, the bridge will be completed between East and West St. John, this enabling the company to conduct an uninterrupted service to West St. John and Fairville. The people of the latter place are petitioning the company to extend its line in that locality as a factor in suburban development. The Suburban Railway Company, which was unable to carry out any of its plans last year, hopes to secure a renewal of its charter and begin construction work this year.

The Browning Company, Cleveland, Ohio, are issuing copies of an excellent catalogue of locomotive cranes. The outside dimensions of this publication are 12 ins. x 9 ins. and the half-tone illustrations, two on a page throughout, are of sufficient size to illustrate the work to the best possible advantage. Browning locomotive cranes have been used on some of the largest constructional undertakings in the world. They came into favorable prominence on the Panama Canal construction, and a single instance of the kind of construction upon which they are figuring in Canada is the extensive harbor work now in progress at St. John, N.B. These cranes can be equipped to handle a hook block, an electric lifting magnet, an automatic bucket of any type, a drag scraper bucket, a steam shovel dipper, or pile driver hammer and leads. Any and all of these are quickly interchangeable with the others, thus giving the owner an all-round machine. The catalogue illustrates and describes a few of the more important details of construction, as well as some of the many uses to which Browning cranes and their various attachments are adapted.

WESTERN CANADA

A brick-making plant has been established at Meyronne, Sask., and will begin operations in the spring.

A large number of contractors have submitted tenders for the erection of the block which the Hudson's Bay Company proposes to erect in Victoria, B.C., on the site at present being excavated by Messrs. Luney Brothers.

Under the terms of an act to encourage housing accommodation in cities and towns, the Manitoba legislature is to empower city and town municipalities to guarantee securities issued for the purpose of building houses of moderate size.

The Regina General Hospital Board has requested the city council to prepare and submit to the ratepayers a by-law granting the necessary permission to raise $175,000 to complete a number of municipal contracts, including a Nurses' Home.

Mr. Southwick, of Vernon, B.C., is reported to have disposed of patents in five countries for his Pressure Water Meter which has been taken up by a syndicate of Vancouver men. This invention is said to work on any water-pipe, even a large three-foot main.

The Mayor of Vancouver has announced that competitive plans will probably be invited for the new city hall and a money by-law put before the electors next January. If this is carried out the new city hall will probably be in course of erection before the end of the year.

Rapid progress is being made on the new million-dollar Law Courts under construction by the National Construction Company at Winnipeg. The contractors are further advanced than they expected to be owing to the unusually favorable weather for building which has prevailed so far this winter.

Hon. Price Ellison, Minister of Finance and Agriculture, formally opened one of the most up-to-date public schools in the interior of the province at Kelowna a few days ago. The school, which involved an outlay of $85,000, is a massive brick and concrete structure designed by Mr. Geo. E. Nobles, of Lethbridge.

The Saskatoon Builders' Exchange, at a special meeting on January 12, passed a resolution expressing the conviction that the proposed law requiring employers of labor to pay in cash or marked cheques every seven days would be impracticable and work a hardship on many in the present financial depression.

Mr. Richard Obee, Secretary of the Board of Trade, Vernon, B.C., has had a communication from an eastern manufacturer who proposes starting a factory in that district for the manufacture of hollow-tile and other clay products. Already samples of clay available in Vernon have been analysed with satisfactory results.

The Canadian Mineral Rubber Company intend proceeding with their large contracts for local improvement in Victoria, B.C. This portion of the work affects some eighteen streets and calls for about 100,000 cubic yards of material, or about $350,000 worth of work. The intention is to proceed with the work gradually during the year.

The announcement was made in Calgary recently that work on Calgary's million-dollar post office would be commenced at once, that Federal engineers were in the city to select a site for an international elevator, estimated to cost one million dollars, and that the contract for the new three million-dollar armoury would be let in the course of a few months.

The Building Inspectors' report to the Kelowna, B.C., city council discloses the fact that the building permits for the twelve months show an increase of fifty per cent., as compared with 1912. The Kelowna Growers' exchange have under consideration the establishment of various plants to handle the by-products of the valley.

A report on the Coquitlam, B.C., dam and city water supply has been presented to Mr. J. B. Challies, Superintendent of the Water Power branch, by Mr. J. R. Freeman, Consulting Engineer for the Dominion Government. Mr. Freeman dealt with the purity of the water supplied from the lake, the stability of the dam, spillway and sluice gates and the area of reservation.

With the object of inducing the Dominion Government to give a preference to local contractors in awarding contracts for government buildings, the Calgary Builders' Exchange at their annual meeting on January 14 endorsed the stand taken by the local board of trade in connection with this matter. The members seemed to think that in the awarding of local contracts they had not been given fair consideration in the past.

Preliminary plans and specifications drawn by the Canadian Stewart Company, of Montreal and Toronto, for a large grain elevator at Port Nelson, the northern terminus of the Hudson Bay Railway, have been approved by the Dominion Government. The elevator will be thoroughly modern and capable of holding several million bushels. The contract will be let in the spring so that the elevator may be ready for use by the time the railway reaches the port. Some fifteen companies are said to have submitted plans.

A new theatre for the Victoria Opera House Company Limited, has recently been erected by Messrs. Penner & MacLellan, general contractors, at Victoria. The building is said to have been completed within sixty days, which is probably a record for large buildings on the Pacific coast. The framework was designed by Mr. H. Bittman, steel engineer, the architects being Messrs. Rochford & Sankey. The main truss holding the balcony is of an entirely new type, and the ornamentation of the interior follows the Louis XVI. period throughout.

One of the most important works which has engaged the engineering department in Victoria, during the past year is said to be the Sooke water works. In spite of difficulties the contract for the concrete floor laying has been awarded and the city will shortly commence the construction of the rivetted steel plate while the balance of the work is under way. By the appropriation of another million and a half dollars the public has reiterated its approval of the scheme, but the latest proposal to acquire the Leach River water-shed at a greatly reduced price has been negatived.

An act to establish public irrigation corporations throughout the province of British Columbia will be introduced by the Hon. Wm. R. Ross, Minister of Lands, at the coming session of the legislature. It will make possible the joint ownership and corporate controlling of irrigation enterprises by the land owners of any locality, where the lands can be irrigated advantageously from a common source of supply or through a common system of works. A petition for incorporation under the Act must be addressed to the Lieutenant-Governor-in-Council, and filed with the Controller of Water Rights.

Mr. Bowser, Attorney-General for British Columbia, has announced that the Pacific Great Eastern Railway interests have been negotiating for some time with the Provincial Government over the closing of the fore-shore rights in connection with the proposed terminals at Newport. The company is said to claim absolute right to the fore-shore, and the Dominion Government and the Pacific Great Eastern practically came to an agreement, but the latter has yet to conclude terms with the provincial authorities. It is said that the Pacific Great Eastern will spend $2,000,000 in harbor improvements at Newport.

The proposal of the Industrial Bureau of Winnipeg to establish manufacturing buildings in a series of units on a portion of the old exhibition grounds, is likely to prove successful, judging from an announcement made by Mr. Chas. F. Roland that all preliminaries for the financing of the $1,000,000 worth of industrial bonds has been practically completed. The site and plans submitted are looked upon by the underwriters as being well thought out to meet a needed want in Winnipeg for economical manufacturing. The scheme, it is said, will afford small concerns with limited capital a better opportunity of getting a foothold, while at the same time catering to the growing trade which is developing in the prairie provinces.

When the new arch bridge at Saskatoon is completed next year, the city will have probably the largest reinforced concrete structure of the kind in Canada. The bridge will span the Saskatchewan River at the intersection of 25th street and Spadina Crescent. The total length of the bridge and retaining walls at its approaches will be about 1,490 ft., the width being 65 ft. The arches, of 150 ft., will be longer in span than any other in the Dominion. Two 8-ft. sidewalks are to be cantilevered from the roadway, while provision is made for two street car tracks and two 14-ft. roadways making ample room for each section. The bridge was designed for a temperature ranging from 50 degrees below zero to 90 degrees above. Under the terms of agreement the city is to pay one-third and the Provincial Government two-thirds of the cost of the structure.

One million dollars was the approximate cost of improvements made by the British Columbia Telephone Company during 1913. These improvements included work in the territory of practically every exchange the company operates, from the west coast of Vancouver Island to the eastern extremity of the Lower Mainland, at Kamloops in the middle interior, and in the Kootenay and Boundary districts. The principal piece of construction was the laying of the direct submarine cable to Vancouver Island from Point Grey, on the mainland. During 1913 new exchanges were erected at Fraser, a suburb of Vancouver, and at Port Coquitlam. Work was inaugurated on the new eight-storey central office building on Seymour street, Vancouver, in which provision will be made for three exchanges. The steel frame work of this building is approaching completion.

A new bulletin on jaw crushers received from Messrs. Canadian Allis-Chalmers Company, Limited, contains some interesting details appertaining to the construction and operation of this equipment. The various types of the company's products are illustrated and the application explained carefully.

Alabastine Hardmortar, Limited, Toronto, have removed their office from 123 Bay street to the corner of Jarvis and Esplanade, where they have opened a warehouse. The firm will thus be more centrally located and their having a warehouse at that point will enable them to handle small orders promptly and at the same time cut down their delivery prices. The manager is Mr. O. A. Cole.

ESTABLISHED 1886

Contract Record
and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **February 4, 1914** **No. 5**

Principal Contents

Page
Work and Opportunities of the Canadian Society of Civil Engineers ... 125
Canadian Clayworkers' Convention ... 126
Building Returns for the Dominion ... 126
Report of the Twenty-Eighth Annual Meeting of the Canadian Society of Civil Engineers held at Montreal ... 127-132
Report of the Twelfth Annual Convention of the Canadian National Clay Products Association held at Toronto ... 133-135
The Architect and His Relation to the Housing Problem ... 135
The Mount Royal Tunnel Entry into Montreal for the Canadian Northern Railway ... 136-151
Paints and their Applications ... 151
Progress at St. John, N.B. ... 154
Proposed Extension of Toronto's Waterworks System ... 152-154
Constructional News ... 156-158

The Work and Opportunities of the Canadian Society of Civil Engineers

THE outstanding event of the past week was the annual meeting of the Canadian Society of Civil Engineers in Montreal, reported elsewhere in this issue. The occasion was the twenty-eighth annual convention. In many respects it bore a marked resemblance to the twenty-seventh annual meeting, the twenty-sixth annual meeting, the twenty-fifth annual meeting and others well within our recollection. Enough comments have been made about this sort of thing, however, to cause us to refrain from taking any further part in the discussion of matters with which we are identified only in the interests of a section of our readers. Last year we were particularly impressed by certain things, and we said so editorially, receiving in response a large number of communications from members of the Society ranking from past-presidents to juniors. Whether or no the discussion to which we refer bore any good fruit may be doubtful in the minds of some, but the fact remains that the subject matter of the discussion provided the basis of the presidential address reprinted on another page.

We believe that the Canadian Society is doing excellent work. This, in fact, is evidenced by the able reports submitted at the meeting—expert reports from which emanated only too little discussion. But there is still room for improvement—witnessed not by the Contract Record alone, but by so active a member of the Society as Mr. H. H. Vaughan, who at the very last session of this convention which has just passed into history counselled those present to endeavor to make their annual meetings worthy of a gathering of engineers, and to spend the greater part of their time in the discussion of technical matters, not in trivial altercations. We feel sure that the great majority of the members will concur in this view, and we cannot but think that the same majority would characterize as unprofessional the frivolities of one or two individual members at the Montreal convention. The convention hall is no place to recount anecdotes and such procedure only cheapens an event which should prove an annual inspiration to every member of the profession. It cannot be urged too strongly that the Canadian Society of Civil Engineers is guiding the destinies of what should be one of the most important professional communities in the country, and the responsibilities of this body cannot be taken too seriously, a point which received proper emphasis at the Convention at the hands of Mr. McNab.

We are entirely in accord with Mr. Vaughan in the opinion that the business procedure of the convention should be disposed of on the first day, so that two days could be set apart for professional experiences. We believe that herein, in the past, great opportunities have been lost.

The attention drawn by the retiring president, Mr. Johnson, to the inadvisability of fanning the flame against the admission of foreign engineers is timely, in a broad understanding. However we may deceive ourselves, we have not yet attained to national manhood, and the helpful experience of the older countries must continue to serve us in good stead in our larger problems, strongly though we resent it. All other things equal, the Canadian-born engineer is entitled to claim preference on government work, but only in such a case—and how often, or rather how seldom, are all qualifications on a parity but the place of birth! It would be a sign of hopeless ignorance to reject the most advanced ideas that outside engineers have to offer, in favor of our own limited practice, merely with a view to protecting individual interest. Is there not something anomalous in the whole thing, seeing that in the past Canada has been dependent to such an extent upon outside sources of aid, whether constructural or financial?

The Society is to be congratulated upon Mr. Butler's succession to its presidency. As a former chief engineer of the Department of Railways and Canals, later Chairman of the Board of Management of the Canadian Government Railways, later again General Manager of the Dominion Steel Corporation, and now the executive head of the firm of Messrs. Armstrong, Whitworth of Canada, Limited, Mr. Butler has a long experience, and a breadth of vision gained therefrom, which cannot but be of inestimable value in the Society's work.

Not a few of the members will acclaim the fact that next year will break the chain of annual conventions in Montreal. Commercial metropolis though it may be, there is nothing particularly lovable about Montreal during a January thaw. We believe that a change of venue will result in "increased enthusiasm."

The Canadian Clayworkers' Convention

IN another column will be found a report of the Twelfth Annual Convention of the Canadian National Clay Products Association, held last week in Toronto. The meeting was perhaps the most successful of its kind ever held in Canada and the clayworkers are to be congratulated upon the fruits of their enterprise.

In his report the President, Mr. Charles A. Millar, spoke in most encouraging terms as to the increased activities in most of the brick and other clay products plants and made the gratifying announcement that negotiations had been completed for establishing a course in Ceramics at the Toronto Technical School. An exceptionally good programme of practical papers was contributed by, amongst others, Professor Coleman, Mr. Joseph Keele, Dominion Geological Survey; Professor Orton, Jr., Dean of Engineering, Ohio State University; and Professor W. H. Day, Ontario Agricultural College, Guelph. The convention was well attended throughout, and the exchange of ideas which resulted from the discussions cannot fail to have a very beneficial effect in the further development of the industry.

Building Returns for the Dominion

RETURNS of building progress throughout the Dominion during the past year are instructive as affording an indication of the volume of construction compared with the previous twelve months. An intelligent study of the figures is sufficient to reveal the fact that behind the gloom which hangs over the industrial world there is beginning to emerge the silver lining which would appear to bear hopes of a bright period of building activity. The total value of building permits issued in 1913 in fifty cities of Canada was $167,518,614, compared with $201,161,550 in the preceding year. Coming to the provinces we find that in the nineteen cities of Ontario for which records were available there was practically no change in the aggregate, the value of permits for 1913 being $51,546,101, as against $51,486,204 in 1912. The returns for Quebec province are $35,245,345 for 1913, as against $26,433,889 in the previous year, an increase of $8,801,456. For the Maritime cities, Halifax, Sydney and St. John, the figures are $3,537,708, an advance of $1,725,622 over the previous year's total of $1,812,086. The western provinces, Manitoba, Saskatchewan, Alberta and British Columbia, all show substantial decreases as compared with 1912, the totals being:—Manitoba, $19,660,490 in 1913, as against $21,815,262, decrease $2,154,772. Saskatchewan, $16,584,485 in 1913, a decrease of $9,567,232 in the previous year's total of $26,151,701. Alberta, $22,367,379, as against $39,424,523, which represents a reduction of $16,057,144. Toronto still maintains its position at the top of the list, with permits valued at $27,038,624, but Montreal is a close second, with Winnipeg, Vancouver, Edmonton and Calgary following in order as to actual total. A remarkable feature of construction in the Maritime provinces is the activity of St. John, N.B., where the permits totalled in value nearly two million dollars in excess of 1912, while a noteworthy increase is also recorded for the province of Quebec. On the other hand, heavy declines are reported from every point in the western provinces with the exception of two or three cities, of which Medicine Hat has the best record. The greatest set-back has taken place in British Columbia, the city of Vancouver in particular faring badly in the general depression. In value of building done Winnipeg occupies a high place not only in the Dominion but in relation to the whole continent. Among Canadian cities the capital of Manitoba takes third place on the list, while there are only five cities in the United States which show a larger total for the year.

These figures, though they show a notable decrease in the aggregate, are at the same time instructive as indicating steady growth in the development that has taken place in comparison with previous years. On every side we hear encouraging reports of the gradual clearing of the industrial horizon, of immense constructional undertakings already planned in practically every part of the Dominion, whilst a feeling of optimism prevails among building contractors generally. With these indications of renewed progress, and the gradual easing up of the money market, we predict with confidence the speedy arrival of a period of unexampled prosperity.

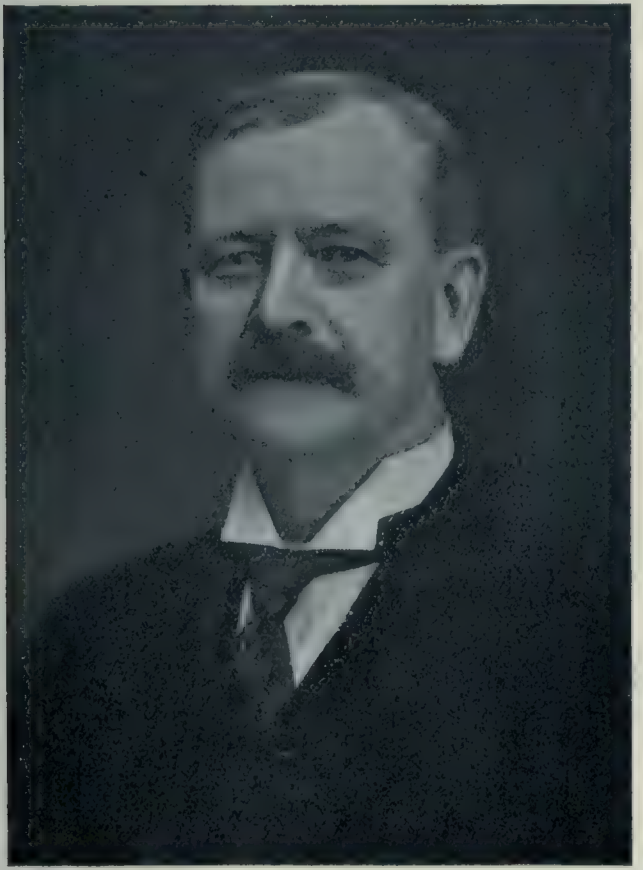
Improvised derrick cars were recently used in the erection of moderate-span single-track deck plate-girder bridges in New Mexico. Each of two ordinary flat cars was provided with a timber tower about 10 ft. high, built over the truck at one end and slightly overhanging the car. Tackles were suspended from these towers, and the latter, being brought up to opposite ends of the completed span, lifted it clear and carried it between them across the falsework to the required position on the line. The falsework was then dropped down, giving clearance for the span to be lowered to permanent position, and the track restored to service with a very short interruption of traffic. The construction of the temporary towers on the flat cars cost less than $200, thus making an economical arrangements which might easily be available under conditions where the services of derrick cars could not be advantageously secured.

The problems of building construction in India are described in an American consular report, which states that one of the most significant recent developments in connection with the construction of large buildings in India has been the increasing use of American reinforcing steel for concrete construction and of various American roofing materials. The use of reinforcing bars has greatly increased economy in the construction of buildings in India. Many houses fall every year during the heavy rains at the break of the monsoon, and as a result chiefly of the disasters, there is now much more rigid official inspection of building operations in the leading cities. Possibly, says the consul, there would be a field in India for architects and building contractors who might introduce more efficient and economical methods, and thus make buildings cost much less and give more safety and comfort.

Civil Engineers in Session at Montreal

Proceedings of the Twenty-Eighth Annual Meeting—Satisfactory Reports Submitted by Branches and Various Committees—A Representative Gathering

THE Twenty-Eighth Annual Meeting of the Canadian Society of Civil Engineers was held last week in the Society's new headquarters at 176 Mansfield street, Montreal. The registered attendance was 331, the membership being drawn from the Maritime provinces in the east to the Pacific Coast in the west, from many points in the United States, and even from England. A number of those who have occupied the highest place in the Society in the past attended the meeting, notably three past-presidents—Lt.-Col. Anderson and Mr. Geo. A. Mountain, of Ottawa, and Mr. C. H. Rust, of Victoria, B.C. Consulting engineers were there in force, but the representation of the municipals was practically in the hands of City Engineer Murdoch, of St. John, N.B., and City Engineer Rust, of Victoria. Local members of the profession in all departments were in strong evidence at the convention. The following is a list of visiting members, the complete list of members in attendance having already been published in various forms. Included in the list is the name of a former contributor to the Contract Record from Kansas City, Mo., namely, Mr. John Lyle Harrington, of the firm of Messrs. Waddell & Harrington. The extent of the recognition of the Society in the United States is evidenced by the attendance of Messrs. F. W. Skinner and P. V. Schmitt, editorial representatives of the Engineering Record and Engineering News respectively. The Old Country was represented by Mr. H. M. Lyon, of Stafford, Eng.



Mr. M. J. Butler, of Montreal, the newly-elected President of The Canadian Society of Civil Engineers.

Visiting Members

L. E. Allen, Ottawa;
Arthur Amos, Quebec;
A. A. Anderson, Ottawa;
Wm. P. Anderson, Ottawa;
J. D. Armstrong, Ottawa;
F. C. Askwith, Ottawa;
H. B. Aylmer, Melbourne, Que.;
Frank A. Barbour, Boston Mass.;
H. E. Bates, Neilsonville, Que.;
W. W. Benny, Ottawa;
F. X. T. Berlinguet, Three Rivers;
Alex. Bertram, Dundas, Ont.;
R. A. Black, Quebec;
W. E. Blue, Ottawa;
Thos. Breen, Quebec;
W. Lyon Browne, Westmount;
Howard Brunlees, Ottawa;
H. C. Burchell, Sydney, N.S.
H. D. Cameron, Winnipeg;
J. M. Campbell, Ottawa;
J. B. Challies, Ottawa;
S. J. Chapleau, Ottawa;
Willis Chipman, Toronto;
E. S. Clements, Toronto;
P. C. Cody, Ottawa;
R. de B. Corriveau, Ottawa;
C. R. Coutlee, Ottawa;
G. C. Coutlee, Ottawa;
A. Crumpton, Port Hope;
R. R. Decary, Quebec;
H. Dessaulles, Shawinigan Falls;
H. McM. Dibert, Troy, N.Y.;
W. J. Dick, Ottawa;
A. A. Dion, Ottawa;
R. L. Dobbin, Moose Jaw, Sask.;
G. Blanchard Dodge, Ottawa.
J. F. Earl, Calgary;
A. C. Fellows, Quebec;
G. H. Ferguson, Ottawa;
A. Douglas Fisken, New York;
A. Fraser, Quebec;
A. E. French, Boston, Mass.;
John S. Galbraith, Toronto;
G. H. Garden, Maberly, Ont.;
L. W. Gill, Kingston;
E. P. Goodwin, Baie Verte, N.B.;
Alex. J. Grant, Peterboro;
Alex. Gray, Ottawa;
J. W. Harkom, Melbourne, Que.;
John Lyle Harrington, Kansas City;
J. B. Harvey, Lyndhurst;
H. E. T. Haultain, Toronto;
M. C. Hendry, Ottawa;
C. S. L. Hertzberg, Toronto;
A. E. Hodgins, Victoria, B.C.;
A. R. Holmes, Sherbrooke, Que.;
J. P. Howe, Cochrane, Ont.;
T. C. Irving, Jr., Toronto;
Hyndman Irwin, Toronto;
F. C. Jewett, Campbellford;
J. T. Johnston, Ottawa;
A. M. Jones, Ottawa;
Newton J. Ker, Vancouver, B.C.;
J. G. G. Kerry, Toronto;
George Kydd, Campbellford;
A. Lainglois, Ottawa;
H. F. J. Lambart, Ottawa;
Wilfred D. Lawson, Ottawa;
A. Leofred, Quebec;
E. E. Little, Ottawa;
Hugh A. Lumsden, Winnipeg;
H. M. Lyon, Stafford, Eng.;
Geo. D. MacKinnon, Sherbrooke;
W. M. MacPhail, Winnipeg;
Duncan MacPherson, Ottawa;
O. Marien, Outremont, Que.;
D. F. Maxwell, Fredericton, N.B.;
G. A. McCarthy, Toronto;
Norman M. McLeod, Toronto;
F. C. Mechin, Toronto;
L. F. Merrylees, Quebec;
C. H. Mitchell, Toronto;
S. P. Mitchell, Philadelphia, Pa.;
Frank Moberly, Barrie, Ont.;
P. E. Moffat, Ottawa;
Romeo Morrissette, Three Rivers;
Geo. A. Mountain, Ottawa;
C. E. Mundell, Boston, Mass.;
Wm. Murdoch, St. John, N.B.;
C. M. Odell, Sydney, N.S.;
E. W. Oliver, Toronto;
Stuart S. Oliver, Quebec;
R. E. Paget, New Hazelton, B.C.;
Harry A. Paquette, Levis, Que.;
C. R. Partik, Ste. Agathe, Que.;
H. McL. Pepperd, Springhill, N.S.;
C. H. Pinkey, Ottawa;
W. M. Reid, Westmount;
J. A. Robert, Ottawa;
W. H. Robert, Beauharnois, Que.;
James Robertson, Lachine, Que.;
Geo. E. Roehm, Walkerville, Ont.;
Richard B. Rogers, Peterboro;
R. M. Roy, Hamilton;
C. H. Rust, Victoria;
H. P. Rust, New York;
P. V. Schmitt, New York;
T. H. Schurtzer, Ottawa;
Frank W. Skinner, New York;
Geo. W. Smith, Milwaukee, Wis.;
J. Tessier, Quebec;
J. A. Tremblay, Montmagny;
R. F. Uniacke, Ottawa;
G. W. Volkman, Ottawa;
James White, Ottawa;
E. T. Wilkie, Toronto;
Geo. R. J. Wilson, Vankleek Hill;
H. S. Windeler, St. John, N'fld.;
M. Wolff, St. Casimir, P.Q.

The opening session was held on the morning of Tuesday, January 27, with the president, Mr. Phelps Johnson, of Montreal, in the chair. The business to be transacted was the nomination of scrutineers and the reception and discussion of the reports of the various committees. The report of the Society's financial standing showed a surplus of $646, a large proportion of the expense account constituting a payment of $50,000 for the new building, upon which a liability of $20,000 still remains.

The report of the Committee on Concrete and Reinforced Concrete was submitted by Mr. Walter J. Francis, chairman, with whom were associated in the preparation of the report the following gentlemen: Messrs. S. Baulne, E. Brown, E. Brydone-Jack, J. Galbraith, P. Gillespie, H. M. MacKay, E. S. Mattice, C. N. Monsarrat, M. Morssen, P. B. Motley and H. Rolph. There was considerable discussion of this report. Mr. Francis moved that it be received and that the committee be continued. Replying to Mr. Brown he explained that in the preparation of their data the committee had followed the most advanced practice of the United States, Great Britain and continental countries. Mr. Elmont urged that the specifications for concrete and reinforced concrete should be separated in the published form. After suggesting various modifications, Mr. Elmont concluded by advocating a reduction in the allowable stress of reinforced concrete. The committee will make a final report at the next annual meeting.

Practical Recommendations of Reinforced Concrete Committee

The following is an extract on Workmanship culled from the report of the Committee on Reinforced Concrete which contained a draft of standard general specifications. Embodied in the extract are the latest modifications and corrections of the Committee.

MORTAR AND CONCRETE

Foundations.—The foundations shall be trimmed as accurately as practicable and shall be at least as large as the dimensions on the approved drawings. Form work shall be erected wherever foreign material can become mixed with the concrete or mortar while the same is being deposited.

The bearing stratum shall be cleaned of all foreign material. It shall also be free from water if practicable. Under no circumstances shall mortar or concrete be deposited in running water.

Form Work.—Form work shall be substantially and accurately constructed. It shall be plumb and true to line, well fixed, braced and supported to carry the imposed loads, and be rigid enough to retain proper alignment and correct contours until the concrete will have become well set. Form work shall be sufficiently tight to prevent leakage. Immediately before depositing concrete the form shall be carefully cleaned out, after having been finally trued up. A thin even coating of soft soap or oil may be applied to new forms. Such a coating shall be applied in every instance where form work is to be used more than once. Form work that has been previously used shall be thoroughly cleaned before reerection and given a protecting coat of the same material as that already used on it. Form work shall be so fastened together that it may be removed without injury to any part of the permanent structure.

Storage of Cement.—Cement shall be stored in a weathertight ventilated building. The floor of the building shall be raised above the ground to ensure dryness.

The cement shall be neatly piled in carload lots in the original sacks, and be marked in a distinctive manner for identification purposes.

Storage of Sand, Crushed Stone and Gravel.—All sand, crushed stone and gravel shall be piled on a site which has been cleaned free from vegetable and other foreign materials.

Measuring of Ingredients.—One sack of cement containing 87½ pounds net shall be taken as equivalent to one cubic foot of cement. All sand, crushed stone and gravel shall be measured by loose volume.

The necessary amount of water to produce the required consistency of mortar or concrete shall be determined from time to time taking into account the atmospheric conditions and the variations of moisture in the sand, crushed stone or gravel before mixing.

All of the materials shall be systematically measured throughout the whole of the work, and the required proportions shall be accurately maintained.

Mixing of Ingredients.—All mortar and concrete shall be made in batch mixers unless it is impracticable to do so, in which case it shall be mixed by hand.

Mixing by hand shall be done on a smooth water-tight platform. The sand and cement shall first be mixed dry until the whole mass is homogeneous and of perfectly even color throughout. Sufficient water shall then be added to make flowing mortar. In the process of making the mortar the materials shall be turned over at least five times. If concrete is to be made wetted the crushed stone or gravel shall then be added and the whole mass turned over at least four times and until it has become homogeneous and of even color and consistency.

Mixing by machine shall produce a homogeneous mass of concrete perfectly uniform in color and even in consistency, the whole mass shall be in continuous motion within the machine for a period of not less than one minute, and the entire batch shall be discharged before any further materials are placed in the machine.

The re-mixing or re-tempering of mortar or concrete which has partly set shall not be permitted.

The general consistency of the mortar or concrete shall be such that the mass will flow readily in the forms, and that it can be conveyed from the mixer to the forms without separation of the ingredients.

The temperature of the mixture on completion of the mixing shall not be less than 40 deg. Fahrenheit. The water, sand and crushed stone or gravel shall be heated, if necessary, to obtain this result. In no case shall crystals of ice either in the sand or in the crushed stone be permitted to reach the mixing platform or the mixing machine.

Placing Above Water.—The surface on which concrete is to be deposited shall be specially cleaned for the purpose. If the surface be rock it shall be given a coat of grout composed of equal parts of cement and sand well brushed into the surface and all the crevices. If the surface, vertical or otherwise, be of concrete which has set hard it shall be spalled or roughened and afterwards thoroughly brushed over with grout composed of equal parts of cement and sand. If the surface be of concrete which has not set hard the spalling or roughness may be omitted, but grout composed of equal parts of cement and sand shall be applied as specified above.

Mortar and concrete shall be placed immediately after being mixed.

Mortar or concrete which has partly set shall not be used.

Concrete shall be conveyed in water-tight carriers and be deposited in such a manner that the ingredients will not be separated, and the mass shall be consolidated by being worked after placing. The coarser ingredients shall be removed from contact with the formwork by the manipulation of a special tool.

The depositing of concrete at expansion joints shall be done with the same care and attention as that required to ensure a smooth finish to exposed surfaces.

In all cases laitance which may have formed on the surface of deposited concrete shall be carefully and entirely removed.

Concrete shall be deposited in approximately horizontal masses, and the work shall be stopped only at regular or temporary vertical bulkheads.

Arch rings shall be built in sections of such lengths as will permit of all concrete in any one section being placed without stopping. If circumstances render this impracticable, bulkheads shall be placed normal to the line of pressure.

In building bench walls or abutments of arches, the tops of such walls shall be finished normal to the line of pressure, and no horizontal joints shall be made.

During freezing weather concrete shall be taken from the mixer and deposited in the forms so that no part of it shall be frozen and the temperature of the mass when deposited shall not be less than 35 deg. Fahrenheit. The concrete shall be prevented from freezing until setting has taken place and until the process of hardening has begun.

Trowelled or floated horizontal surfaces shall be not less than one inch in thickness. They shall be composed of mortar or concrete proportioned according to the requirements for wear. The mortar shall contain at least one part of cement to one part of sand and one part of finely crushed rock or gravel.

If possible the surfacing shall be applied immediately after the placing of the mass concrete, but when this is impracticable the mass concrete shall be thoroughly washed and treated with a coat of grout composed of equal parts of cement and sand thoroughly brushed in before the surfacing is applied. In trowelling or floating the surface pure cement shall not be used.

Curing.—Concrete shall be protected from the direct rays of the sun for at least three days after being deposited when the maximum temperature is above 60 deg. Fahrenheit in the sun.

For a period of seven days after being deposited concrete shall be kept moistened when the maximum temperature in the shade is above 60 deg. Farhenheit.

Form Removal.—The forms shall not be removed from concrete work until the concrete is safely self-supporting, and, where additional concrete is to be added, until it has sufficient strength to safely sustain the superimposed load.

Placing Under Water.—When concrete is to be deposited under water the site shall be cleaned from all foreign matter and all currents of water shall be eliminated. The concrete shall be deposited immediately after mixing in such a way as to displace the water and at the same time to obviate the separation of the ingredients. The work shall be carried on in such a manner as to prevent the formation of laitance between successive masses of concrete.

REINFORCED CONCRETE

General.—All the requirements of the preceding sections shall apply to reinforced concrete as far as consistent.

Crushed Stone and Gravel.—The largest fragments of crushed stone or pieces of gravel for reinforced concrete shall be of such a size as to pass through a circular hole ¾-in. in diameter in a thin plate.

Storage of Steel.—Steel shall be stored on skids clear of the ground and protected from rain and snow.

Fabrication and Placing of Steel Reinforcing.—All steel reinforcing shall be fabricated and placed in strict conformity with the dimensions of the approved drawings, and it shall be truly lined up and so held in position that displacement shall not occur during the depositing or manipulation of the concrete. All bars shall be free from bonds not specifically required by the approved drawings.

No material shall be permitted to adhere to the surface of the steel reinforcing until the concrete in which it is to be embedded is being deposited.

Cleaning of Form Work.—Immediately before depositing the concrete the form work shall be entirely cleaned of all foreign material, preferably by the use of a pressure hose and nozzle discharging water, steam or air.

In column forms an opening shall be provided at the bottom of the form work of every column in order that every particle of foreign material may be readily removed.

Depositing of Concrete.—The concrete shall be deposited in small quantities preferably as a uniform stream. It shall be manipulated in such a manner as to ensure perfect adhesion to the entire surface of the steel reinforcing and to remove all impounded water or air.

In depositing concrete in columns the work shall be discontinued at the elevation of the bottom beams for a period of not less than three hours before depositing the beam concrete. In the absence of beams the elevation of the bottom of the slab shall be taken as the stopping place. Before commencing the depositing of the beam concrete (or slab concrete in beamless systems), every column shall be examined for laitance, which if present shall be immediately removed.

The concrete for slabs shall be deposited continuously with the beams. Special care shall be exercised to procure perfect homogeneity of tee-beam construction.

Discontinuance of Work.—Every structural element shall be completed without discontinuance if practicable. Unless completed in one operation, beams and slabs shall be discontinued only by the use of vertical bulkheads placed at the section of maximum bending moment.

Freezing Weather.—In protecting reinforced concrete from frost a system which will drive the moisture out of the concrete shall not be used.

Form Removal.—The forms shall not be removed until the times named in the following table have elapsed after depositing concrete, not counting periods in which the temperature has been below 35 deg. Fahrenheit.

Part	Minimum number of 24-hour days elapsed after depositing
Posts under beams and girders....	20
Floor slab panels	10
Wall forms	2
Column forms	4
Sides of beams and girders	4
All other parts	10

CINDER CONCRETE

General.—All the requirements of the preceding sections shall apply to cinder concrete as far as consistent.

Storage of Cinders.—Cinders shall be stored on a site which has been cleaned free from vegetable and other foreign materials.

REINFORCED CINDER CONCRETE

General.—All the requirements of the preceding sections shall apply to reinforced cinder concrete as far as consistent.

Size of Cinders.—The largest particles of cinders for reinforced concrete shall pass through a circular hole ¾-in. in diameter in a thin plate, and none shall pass through a circular hole 1/8-in. in diameter in a thin plate.

RUBBLE CONCRETE

Soundness of Boulders and Rock.—All boulders and pieces of rock shall be perfectly sound, impervious and durable.

Embedding Rubble.—All boulders and pieces of rock shall be thoroughly cleaned of foreign material, and after being wetted they shall be either floated into the concrete matrix or placed upon a floating bed with full bearing, in which case the concrete, as it is being raised around them, shall be manipulated in a manner similar to that required for exposed faces of walls. The mortar in the concrete shall be made to adhere perfectly to every part of the surface of the boulders and rock.

The report of the Board of Examiners was submitted by Mr. MacKay, who dwelt upon the necessity of maintaining high standards. The matter of appointing a committee to consider general clauses in specifications was brought up by Mr. French, whose motion finally carried after considerable discussion in which Messrs. Johnson, Butler, Francis and Mitchell participated.

Upon the adjournment of the Tuesday morning session, the visiting members were entertained to luncheon by the Montreal members. The occasion was a purely informal one and the speeches complimentary only.

At the resumed session on Tuesday afternoon the report of the Committee on Sewage Disposal was presented by Mr. Willis Chipman, of Toronto. The great importance of this work was emphasized by Mr. Leofred and others and it was decided to retain the committee and give it power to increase its membership.

The report of the Committee on an Improved Engineering Service was submitted by Col. Anderson, who deplored the fact that engineers employed under the Dominion government outside of Ottawa were only placed upon a temporary basis. It was urged that a delegation should go to Ottawa to make proper representations to the government. The committee will continue its work.

Following the reception of the report of the Committee on Steel Bridge Specifications the following gentlemen were appointed a committee on Cast Iron Water Pipes and Specifications:—Messrs. T. C. Irving, Jr., chairman; Newton J. Ker, A. Currie, F. H. Pitcher, C. H. Mitchell, F. Leofred and C. L. Fellowes.

On the whole, satisfactory reports were made by the various branches, which consist of Quebec, Toronto, Kingston, Winnipeg, Calgary, Victoria and Vancouver.

The afternoon session was brought to a close by the presentation of the presidential report of Mr. Phelps Johnson. We reproduce this report in full, as it is devoted entirely to a consideration of the various matters regarding the progress and usefulness of the Society which came in for such extended discussion in these columns after the last annual meeting.

PRESIDENT'S ADDRESS

It is decreed by custom that a retiring President of the Society shall make an address. A good number of my predecessors in the office, following what was probably to them the line of least resistance, have given you a paper on some engineering topic.

I considered following this course, but abandoned the idea for the reason that it seemed impracticable to treat in a satisfactory way a problem in bridge construction without the aid of diagrams and lantern illustrations.

A general review of the progress made in the different fields of engineering, or a review of the more important works that have been carried out in Canada, are both beyond my limitations. I shall, therefore, speak to you only on Society matters, and I am the more ready to do this for the reason that at our last annual meeting and later in published correspondence, complaint was loudly voiced that the Society was not doing enough for its members, and the Officers and Council of the Society did not escape serious criticism.

The objects and purposes of the Society are in its Charter stated to be, "to facilitate the acquirement and interchange of professional knowledge among its members."

It seems evident that this basic purpose of the Society can best be achieved by having enrolled in its membership a large proportion of the able and active engineers of the country, by the interchange of thought and of experience at its meetings and particularly by the reading, discussion and circulation of papers on important and interesting works or investigations.

The Society was organized 26 years ago by a few of the then prominent engineers of Eastern Canada. The movement met with the enthusiastic support of most of the engineers then in active practice, and at the time of the first annual meeting in 1888 there were 225 members and 65 associate members, or a total corporate membership of 290. From that date the number has steadily increased until we have at the present time 622 members and 1,313 associate members, or a corporate membership of 1,935. A few of these members, less than 40 in all, have come in under the Quebec Act, and a few more in this province have joined almost under compulsion because of the Act, but the large majority have joined without pressure and without special solicitation, evidently because they considered membership in the Society beneficial and that to belong to it gave them a standing in the profession and in the community that otherwise they would not have.

While the growth of the Society in numbers has been very satisfactory there has been no corresponding growth in the enthusiasm of its members, as evidenced by attendance at the meetings, by the preparation and contribution of papers, or of discussion on the papers submitted, but rather the reverse. The first eight years of the Society's history there was an average corporate membership of 378 and an average of 13 papers per year were submitted, read and published. The last 18 years the average corporate membership has been 921 and the average number of papers per year, again 13. In the first 8 years a paper was presented by one member out of 29. During the last 18 years we have had one paper for each 71 members. During the last 3 years we have had one paper for each 132 members.

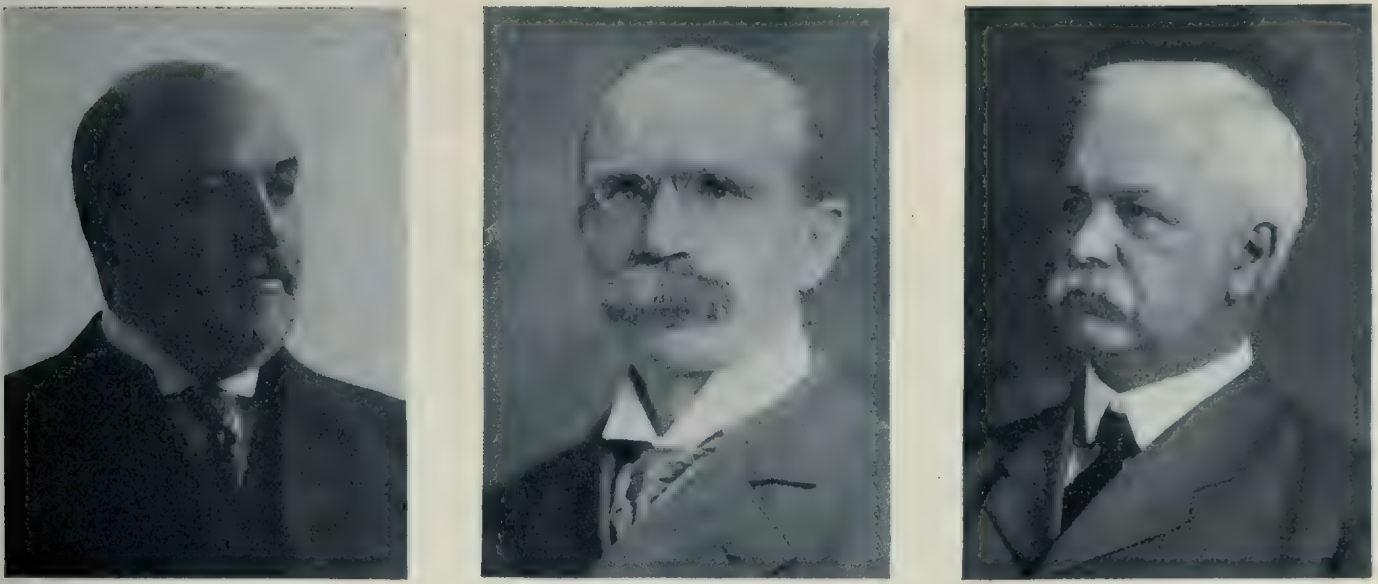
Real enthusiasm cannot perhaps be worked up to order, but we can all do our duty, and I would call to your attention that following our election we have all agreed "to promote the objects of the Society so far as in our power," and "to present to the Society an original communication" (meaning a paper) "or some scientific work for the library."

I fear a great many members have so far overlooked this pledge and hope for a great increase in the number of papers in the near future. I would particularly urge that the younger members prepare and submit papers describing the work on which they are engaged, or of which they have good knowledge, and this as much for their own sake as for the good of the Society, for the presentation of a paper of merit will go a long way toward giving them a professional standing they cannot well gain in other ways. A good paper need not necessarily be based on a large and important work, or even a successful one, for failures are often the source of very valuable information.

In connection with the complaint that the Society has not been doing enough for its members, it will be interesting to inquire what other societies of similar nature are doing for their members. The societies which at once come to mind for comparison are the Institution of Civil Engineers of Great Britain and the American Society of Civil Engineers. Both of these societies have been long established and have a large membership, both have accumulated valuable properties and have annual surpluses of revenue over ordinary expenditures greater than our entire gross revenue. With ample means at their command and with able management it would seem that we may reasonably expect to find these societies rendering their members every obvious useful service.

The British Institution of Civil Engineers publishes and distributes to its members four volumes per year, each volume containing the reports of the meetings that have been held since the last issue and a list of those admitted as students or as members, or transferred from one class to another. The papers read at the meetings and the oral and written discussions thereon are published, as well as a number of "selected papers" which apparently have not been read and discussed but are considered worthy of publication. A good part of each volume is devoted to "Abstracts of Papers in Scientific Transactions and Periodicals," a typical volume devoting over 100 pages to short reviews of 170 selected articles. The abstracts in the volume examined bear the initials of thirteen different reviewers, and this suggests that the work is not done by the Secretary's staff, but by writers familiar with engineering subjects, specially engaged for the work.

The American Society of Civil Engineers publishes in



Mr. Geo. A. Mountain,
Ottawa.

Mr. C. H. Rust,
Victoria, B.C.

Lt.-Col. Anderson, C.M.G.,
Ottawa.

Three Past-Presidents of the Canadian Society of Civil Engineers who took an interested part in the proceedings of the Montreal Convention.

pamphlet form ten volumes of proceedings per year, each containing brief reports of the meetings of the Society and of the Board of Direction, which corresponds to the Council of this Society, the names of members elected and transferred from one class to another, a list of additions to the library with a synopsis of the contents of the more important books and gives a list of recent engineering articles of interest, reviewing for this purpose more than 100 publications. Each volume also contains a number of original papers with the discussions thereon.

It will be seen that both of these societies not only publish their transactions more frequently than our society, but go to considerable expense in keeping their members advised as to recent engineering literature.

Aside from their activity in this direction I am unable to find that these older and larger societies do their members any service which we are not endeavoring to do for our members, and it is to be borne in mind that these societies are financially able to do for their members every useful service considered desirable.

Neither of these societies has branches or divisions corresponding to our own, though there are a number of local "Associations of Members of the A. S. C. E." in various parts of the United States which hold regular meetings and read and discuss papers as do our branches. These associations have Charters approved by the parent society but receive no financial assistance from it.

Apparently the only useful suggestions we can get from the practice of these two older societies was the desirability of more frequent reports to the membership, and keeping the members advised of current engineering literature, the latter a matter of considerable expense which the finances of the society have not heretofore permitted.

The criticisms made at our meetings and in correspondence have as a rule been very general and with few specific suggestions. There seems to be a feeling that the officers and the Council are not doing all they should, that they are not keeping the members well posted, that the Council is not fairly representative of the different districts, and that it would be well if its members were younger and more enthusiastic and if they served shorter terms.

The remedy for these faults, if they exist, is in the hands of the membership at large, for it can make and alter by-laws, can designate the Nominating Committee, and can elect Councillors, and through them control the policy of the Society.

Some of the members, I believe a very small proportion, evidently feel strongly that the Society should interest itself in the troubles of its individual members, with the municipalities and corporations employing them, and particularly that the Society should take active steps to keep out so-called alien engineers, and conserve Canadian business for the members of the Society.

I can conceive of no course so sure to discredit and disrupt the Society as to adopt labor union methods, and interfere in the disputes of engineers with their employers.

I agree that Canadian work should as a rule be done by members of this Society, but pressure to this end can best be exerted by the local members and branches, and I feel strongly that except in connection with works handled direct by the Dominion Government, the Society should not officially intervene.

On the whole I consider the complaints that have been made to have little support in existing conditions and believe that the Society has in the past done for its members about all that could reasonably be expected. I do think, however, that the members of the Society have in great measure failed to do for the Society and for themselves all they should and believe they can hereafter, by taking a more active interest in it, by contributing and discussing papers, by attending meetings of the Society and Branches, by paying more attention to the application for membership and advising the Council in regard thereto, and in other ways, make the Society of use to themselves and at the same time promote its interests.

In conclusion I wish to point out one way in which it may be the Society can be of great use to members without engagements or desirous of changing their employment.

The suggestion comes through the Engineering News of the 21st of August last, which, in an article headed "Making Membership in an Engineering Society a Tangible Asset," states that the "Junior Institution of Engineers" in England, a Society of which I have no special knowledge, has undertaken the establishment of a permanent Engineers' Register which will give a complete record of the professional career of every member, the purpose being to form a sort of clearing house to assist members in improving their positions by systematically recording the particulars of their experience and technical training, and by effecting the introductions to engineering employers of members who possess such qualifications as may fit them for vacant positions. To establish and maintain a Register of this nature would involve considerable expense, and would require the hearty co-operation of all members. I think, however, the suggestions well worthy the serious consideration of the incoming Council.

Wednesday morning was set aside for a visit to the works of the St. Lawrence Bridge Company at Rockfield and a good-sized party left the Windsor Hotel on the special cars provided by the Montreal Tramways Company. After an inspection of the works the members were entertained at luncheon by the Bridge Company.

On Thursday afternoon a number of members took advantage of the invitation extended by Mr. S. P. Brown, chief engineer of the Canadian Northern Montreal Tunnel and Terminal Company, and made an inspection of the tunnel. The tunnel work is described in detail in this issue.

Practically the sole topic at the resumed business session on Wednesday afternoon was the relation of the Society to its Branches, the situation arising out of the disposition of the British Columbia branches towards forming a provincial division of the Society in British Columbia. The discussion veered around to all points of the compass and constituted what was practically a re-hash of the correspondence on this subject published in these columns some months ago. The outcome was the approval of a resolution by Mr. J. W. Harkom to the effect that the matter should be referred to a special committee of the council, which will report by November 1 next. The subject came up for discussion again on Thursday morning, when, at a very small gathering of the members, Mr. J. W. Harkom's resolution of the previous day was rescinded in favor of a motion by Mr. Kerry. A standing vote showed thirteen for the amended resolution and eight against. A strong protest was made against the unrepresentative character of such a vote.

A rather prolonged discussion as to means of increasing interest and enthusiasm in the affairs of the Society was fruitless, an aimless series of addresses being brought to a close by a few pointed remarks from Mr. Vaughan, who deplored the waste of time occasioned by the complaints of disgruntled members, urging that these annual conventions should take on a more engineering aspect, instead of developing into nothing but a "family scrap." The business end of the meeting, together with the acceptance of the various branch reports, should be disposed of in three hours, Mr. Vaughan contended, leaving two clear days at the disposal of the members interested in the advancement of things purely professional. Following Mr. Vaughan's observations there was some further argument and eventually a motion in favor of appointing a committee to look into the matter was submitted and lost.

Annual Dinner of the Society

The annual dinner of the Society was held at the Engineers' Club, Montreal, on Wednesday evening, January 28. Mr. H. H. Vaughan presided in the absence of Mr. Phelps Johnson, the retiring president, who was suffering from a severe cold. The place engineers have taken in the building of Canada and the splendid prospects of the profession were the chief topics of the various speakers. The fact that Confederation would not have been possible without those engineers who had the broad vision, the imagination and the practical ability that brought into being the C. P. R. and the Intercolonial was recalled by Col. Anderson in responding to the toast, "Our Country." Mr. F. L. Wanklyn lamented the ignorance prevailing abroad regarding the great progress that Canada has made and her engineering achievements. He warned those present against wild-cat schemes and urged that all reports should be honest and reliable.

One of the social events of the convention was an enjoyable "Smoker" in the club rooms on the evening of Tuesday, January 27.

The convention came to a close with a session of the council on the afternoon of Thursday, January 29.

The officers elected to serve on the Council of the Society are as follows:—President, Mr. M. J. Butler, C.M.G., Montreal; Vice-President, Mr. R. A. Ross, Montreal.

Councillors: Representing District No. 1, Montreal and district within 25 miles,—Messrs. J. M. R. Fairbairn and H. M. MacKay, Montreal. Representing District No. 2, Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick and the United States —Mr. R. McColl, Halifax. Representing Dsitrict No. 3, Province of Quebec (outside of the Headquarters district), countries outside of Canada, Newfoundland and the U. S. A.—Mr. A. R. Decary, Quebec. Representing District No. 4, Ottawa and the Province of Ontario east of and including Lindsay—Mr. R. F. Uniacke, Ottawa. Representing District No. 5, the Province of Ontario west of Lindsay—Mr. W. A. Bucke, Toronto. Representing District No. 6, the Provinces of Alberta, Saskatchewan and Manitoba—Mr. F. Lee, Winnipeg. Representing District No. 7, the Province of British Columbia—Mr. G. R. G. Conway, Vancouver.

In a paper before the American Institute of Electrical Engineers, Mr. Charles Fair dealt with the advantages of electric driving for machine tools. Much of the success of a motor-driven machine, he said, depends on its control. There are certain other advantages in the individual drive, but the principal is that it enables the one machine to be controlled to suit the work, with accuracy and with the minimum strain and labor on the part of the machinist and shop laborers. Speaking generally, the individual drive is fitted to costly machines where it is specially important to cut down the time taken in setting up, adjusting, and setting in motion to the minimum.

The large storage dam across the Swift Current river, which will insure a supply of water for a population of over 50,000, has been completed. The dam, which is over 800 feet in length and 25 feet in height, was constructed by the Ambursen Hydraulic Construction Company, of Montreal, under the supervision of Mr. G. K. Mackie, town engineer. Its total cost was $100,000.

Fireproof wooden shingles are being made in the forest products laboratory of the University of Wisconsin at a cost of $15 per thousand. The method consists in forcing into the wood, under pressure, such chemicals as ammonia sulphate and ammonia phosphate. It is claimed that the new process is commercially practicable, and extended experimenting is expected to lower the cost.

Clayworkers in Force at the Queen City

The Most Influential and Representative Conference of this Industry ever held in Canada.—Interesting Addresses by President Falconer, of the University of Toronto, and Others — Practical Discussions of Many Trade Topics

THE twelfth annual convention of the Canadian National Clay Products Association opened on Tuesday, January 27, in the King Edward Hotel, Toronto. Nearly two hundred members attended from different parts of Canada, and many other affiliated members from the United States were also present. Mr. Charles A. Millar, president of the association, in opening the convention said there was every evidence of brighter times and greater business ahead, as the present year promised to be one of the brightest in the country's history, not only in the production of brick but also in the manufacture of iron and other products.

Mr. Chas. A. Millar, Toronto, re-elected President of the Canadian National Clay Products Association. During Mr. Millar's year of office the Association has made the greatest progress of any corresponding period in its history.

Controller J. O. McCarthy, who welcomed the delegates on behalf of the city, spoke most optimistically regarding the future of the clay-working industry, stating that reports from the various firms connected with the association throughout Canada showed that they were obliged to take on more employees to meet the orders steadily pouring in, and that many plants which had been closed during the year were again opening with a full list of orders. A couple of months ago many firms had large quantities of brick undisposed of, but now these were all purchased, and the demand was growing. This not only indicated fair conditions in the money market but also great activity in the building trade. Each month he believed the industrial situation would become brighter. This was clearly reflected in the selling of the city bonds.

Mr. J. S. McCannell, of the Milton Pressed Brick Company, responding on behalf of the Association, said they all felt very much relieved by the encouraging remarks made by Controller McCarthy regarding the bright prospects for the clay products manufacturers in the near future. Mr. D. A. Lochrie, a past-president of the Association, welcomed the delegates on behalf of the Toronto Clay Products Association.

The president in his report pleaded for a closer bond of union among the brick men of Canada, this with a view to the standardization of the various kinds of brick with regard to price, etc., as in the United States. Referring to the provision for a course of ceramics in the new technical school he announced with gratification that spacious rooms had been assigned to them in order that a full course in this subject would be available.

Mr. John R. Walsh, secretary-treasurer, submitted his report which showed a substantial credit balance and also an increased membership.

The choice of officers for the year 1914 resulted in the following being elected:—President, Mr. Chas. A. Millar, re-elected; Vice-Presidents, Mr. P. H. Stephens, Portage La Prairie, Man.; Mr. J. S. McCannell, Milton; and Mr. J. E. Frid, Hamilton. Messrs. D. A. Lochrie, A. L. McCredie, C. A. Lewis, Angus Germain and Gordon Keith were elected on the executive committee. Messrs. J. S. McCannell and D. O. McKinnon were elected auditors.

There was a very large attendance of delegates at the second day's session of the convention and several papers on various phases of the industry were read.

"Formation and Different Kinds of Clay"

This was the title of a most instructive address delivered by Profesor A. P. Coleman, of Toronto University. In an opening reference to the Don Valley deposits, especially the Don Valley brick yard, Professor Coleman stated that there we had a sheet of boulder clay resting on the shale, then stratified deposits formed in a lake, then another sheet of boulder clay above. The boulder clays are glacial deposits, and the beds between are inter-glacial, which showed that there had been a time of warm climate between two ice ages. In the inter-glacial time there had been a great forest growth in the Don Valley, with trees like those of Pennsylvania or Ohio. Now some of the trees were extinct as also were animals, for instance deer larger than a moose, the buffalo and the mammoth mastodon which lived here.

From the brick-makers' point of view the most important feature was the red brick clay formed in the inter-glacial period. This was the best brick material around Toronto. The ordinary clay around Toronto was boulder clay, which contained too many stones to make good brick material. The glacial lake clays had been deposited under water and were free from stones, but they contained so much lime that they made buff brick. Two or three feet of the surface was generally leached, giving a red brick clay. The whole of the inter-glacial clays were of the leached material giving a fine color of red brick. At Scarborough there are 90 feet of these inter-glacial clays, but unfortunately they are covered by more than two hundred feet of other drift materials, so that they are not available for the brick-man. The clay bank which runs from the Niagara Peninsula, through Milton and Hamilton, and east to the outskirts of Toronto, was one of the best on the continent and practically inexhaustible. Professor Coleman said, in conclusion, that last summer when he conducted a party of geologists from all over the world to the Don Valley brick yard they were immensely interested in the inter-glacial beds. Dr. Horne, of the Scottish Geological Survey, said that it was worth the whole journey from Scotland to have had the opportunity of seeing that section.

The paper was followed by an interesting discussion.

"Ceramic Schools and Their Value" was the subject of a paper contributed by Professor Edward Orten, Jr., Dean of Engineering, Iowa State University, who spoke strongly in favor of every technical institute having a course in ceramics. It was one of the important courses in the Iowa University, and he himself had been connected with the subject for the past twenty-five years. He traced the history of the course in that university and gave a brief account of its growth in popularity in the various schools and colleges in America, concluding by advising the establishment of a course of ceramics and also of test laboratories in the various technical schools throughout the Dominion.

Mr. J. S. McCannell, Milton, Ont., one of the Association's vice-presidents.

Dr. McKay, L.L.D., Principal of Toronto Technical School, was to have addressed the Convention on the Toronto Course of Ceramics to be started in the Technical School, but was unavoidably prevented through illness from attending.

Mr. Joseph Keele, of the Dominion Geological Survey, read a paper on "Lame Ducks in the Clay Products Business." He ascribed the failure of certain brick plants largely to over-capitalization, mismanagement and going into the manufacture of brick where the clay deposit was not very extensive and petered out. He also showed that had an investigation been made beforehand and some common clay taken and mixed with a portion of good brick clay the manufacture of an excellent brick would have been the result. And besides it could have been made to last a good deal longer.

Types and Construction of Kiln Furnaces

A paper on this subject was prepared by Mr. John F. Wilde, ceramic engineer with the E. H. Crandell Pressed Brick Company, of Calgary, and read by Mr. Gordon C. Keith. The paper dealt with five different types of furnaces. Additional interest was lent to the article by a number of black-board illustrations which accompanied it. An interesting discussion followed in which Messrs. A. M. Wickers, J. W. Ball and Miller Gibson contributed their views on the question mainly of how much air was necessary for the burning of brick.

The subject of "Brick Yard Kinks" was ably dealt with in a paper read by Mr. A. F. Greaves-Walker, ceramic engineer with the Sun Brick Company, Toronto. Mr. J. E. McElroy, of Dayton, Ohio, contributed a paper on "Burning of Clay Products," and Professor W. H. Day, Ontario Agricultural College, Guelph, spoke on "Tile."

Ceramics in the University

Dr. R. A. Falconer, M.A., president of Toronto University, was present during the morning session on Thursday, and contributed an interesting address dealing with the subject of Ceramics in the University. He said that last year the Clay Products Association waited on him, and this year he thought it only right that he should attend their convention and report on what the Clay Products Association had requested the University to do. He had to report progress but as far as the present finances of the University were concerned they found themselves unable to finance the proposed course. They were in hopes, however, that the Dominion Government would be prevailed upon to extend the work somewhat that they were carrying on at the University at the present time. Already thirty students, most of them final year men, were taking ceramic work at the University and many of the theses of these men would be written on the subject of the manufacture of clay products. At present Mr. Joseph Keele was established at the University doing certain work for the Dominion Government and they had his assistance in arranging the work for those students who wished to make a study of clay products. It was the intention of the government to establish laboratories in Ottawa for the testing of all classes of the material. This, however, would probably take years to establish and they should, therefore, temporarily at least, establish laboratories at certain centres to carry on the local investigations necessary for certain work. Carrying out this idea, laboratories should be established at Toronto University, and as soon as they were able to finance them proper courses in ceramic engineering would be given, these laboratories forming the basis of the course which would be along the same engineering lines as those established for civil, mechanical, electrical, mining and roadway engineering, the last named being closely allied to the clayworking industry. Concluding Dr. Falconer said he was glad to report this progress and asked for the moral support of the clay products manufacturers until they were in a position to bring this course to a successful conclusion.

An interesting discussion followed Dr. Falconer's speech, those taking part including Dean Galbraith, Faculty of Engineering, Toronto University; Professor Ramsay Wright, Mr. Joseph Keele, Dominion Geological Survey. A resolution was unanimously adopted on the motion of Mr. Gordon C. Keith, seconded by Mr. Daniel A. Lochrie, expressing hearty approval of the effect of the establishment of testing laboratories by the United States government, and the announcement from President Falconer that pressure was being brought on the Dominion government to establish such laboratories for the benefit of the clay industries in

Canada. It was decided to circulate the resolution among the members for signature, same to be presented subsequently to the Deputy Minister of Mines.

An important discussion took place regarding the establishment of a testing laboratory in the University, and a resolution was unanimously passed on the motion of Mr. McKinnon, that a committee composed of members of the Executive and others go into the matter without delay.

Fireproofing—Manufacture and Burning

Mr. Miller Gibson, ceramic engineer, National Fireproofing Company, read an instructive paper on "Types of Hollow-Tile Fireproofing—Their Manufacture and Burning." A synopsis of the paper will appear in our next issue.

Friday's Session

The convention closed on Friday afternoon with a series of interesting papers followed by the installation of officers for 1914. The history of the Clay Products Association was reviewed by Mr. D. O. McKinnon. Mr. M. E. Gregory, president of the Brick, Terra Cotta and Tile Company, Corning, N.Y., discussed "The Commercial Side of the Clay Business," and a paper on "The Making and Burning of Tile" was contributed by Mr. W. H. Moodie, Highgate, Ont. "The Possibility in the Advertising of Clay Products" was the subject of a paper by Mr. A. L. McCredie, Toronto, and a resolution was passed advocating the advertising of brick. Mr. M. B. Cheney, ceramic engineer with Shale Products, Limited, Inglewood, also read a paper. A feature of the proceedings was an address on "Advertising," by Mr. H. N. Casson, New York. Mr. Casson also addressed a large audience at a luncheon in McConkey's Restaurant, under the auspices of the Convention.

Mr. John R. Walsh, Toronto, Secretary of the Canadian National Clay Products Association.

The public accounts of the province of British Columbia for the fiscal year ending March 31, 1913, show that the sum of $4,790,461 was spent on roads, streets, bridges and wharves, and $2,815,648 on works and buildings, which means an expenditure of about $5,000,000 in public works.

The Architect and His Relation to the Housing Problem

BEFORE a recent meeting of the Vancouver Branch of the British Columbia Society of Architects, Mr. H. H. Stevens, M.P., read an instructive paper on "The Architect and His Relation to the Housing Problem." After an opening reference to architecture as one of the most ancient of arts, and the architect in his early history simply a master-builder, Mr. Stevens discussed the powerful influence of ancient architecture upon the national life. Egypt he referred to as the most ancient example of architecture, dating as far back as 5,000 B.C., and to which we were largely, if not solely, indebted for the history of that wonderful civilization. Contemporaneous with the latter period was that of Syria and Mesopatamia, then followed the Persian and Syrian age about 500 B. C. to 350 B. C. Then commenced the era of Grecian art remarkable for its grace, beauty and wealth of detail, and which so deeply affected the life of the whole Roman empire. The two great orders of Grecian art, the Doric and the Corinthian, formed the roots of all subsequent types of European architecture.

The introduction of Grecian architecture into other parts of Europe greatly developed the Romanesque style, which in turn brought forth the Gothic, reaching the culmination of its perfection in the thirteenth century rivalling in beauty the art of ancient Greece. Mr. Stevens next described the Mohammedan type which followed in the main the earlier Byzantine style in Northern Africa, Asia Minor, India and Europe. The architect should combine artistic perception, technical knowledge and business training, and these qualifications should take precedence in the order mentioned, but none of them should be omitted from the acquirements of the competent architect. He required the artistic perception to conceive the design, the technical knowledge to reduce the confidence of his principals so that he might be the director of operations rather than a mere hireling. In the larger sphere of national undertakings the architect should become the recorder of the nation's history in the types of building produced after the manner of the ancients, combining present use with lasting qualities.

Discussing the subject with relation to the housing problem he suggested that the architect should also be a sanitary expert, at least that he should understand the principles of sanitation, for the first duty of the public man and of all responsible citizens was properly to conserve the health and social conditions of the people. In the course of a detailed reference to the design of buildings in western cities, Mr. Stevens referred to New York as affording a striking example between the old-fashioned dumb-bell tenement and modern apartments with each room accessible to fresh air. Summing up his remarks he said:—"Your art is as old as civilization. It has been the medium from which past stores of valuable knowledge have been prepared for mankind. In all ages it has a marked effect upon the race, moulding national life and elevating thought and ambition. It is an honorable and inspiring profession worthy of a man's best effort. You may stamp for all time your personality upon the great public buildings of our land, and you may also engrave your name on the more obscure but none the less lasting life of the people by giving the poor of the congested centres health and happiness in the buildings you design for their habitation."

The Mount Royal Tunnel Entry into Montreal for the C. N. R.

THE Canadian Northern Railway now has under contract about 2,500 miles of railroad, which when finished will complete its Transcontinental System, with a total mileage of over 10,000. The greater part of this mileage is in the grain fields of the middle West, where that great mass of traffic originates which has made Montreal the second busiest harbor on the American continent. It is largely this enormous grain traffic, amounting often to over 1,000,000 bushels of wheat alone per day, that has enabled the Canadian Northern to pay the interest on its bonds, invariably, the first year of operation, on every line opened in the West. In regard to economy of operation it is also interesting to note that the Canadian Northern Transcontinental line not only has the flattest grades but also the lowest summit of any line crossing the Rocky Mountains. When this line is completed in 1914 it will be the second transcontinental system to be operated in Canada. With this immediate completion in view it became imperative to develop such terminal facilities in Montreal (see Figure 1) that this new artery should never become congested and that the ever-increasing traffic should be encouraged to the fullest extent. In this the forehanded policy of the Montreal Harbor Commissioners and the progressive character of their Chief Engineer, was a great incentive, their plans anticipating extensions and improvements with which the Canadian Northern was most heartily in accord.

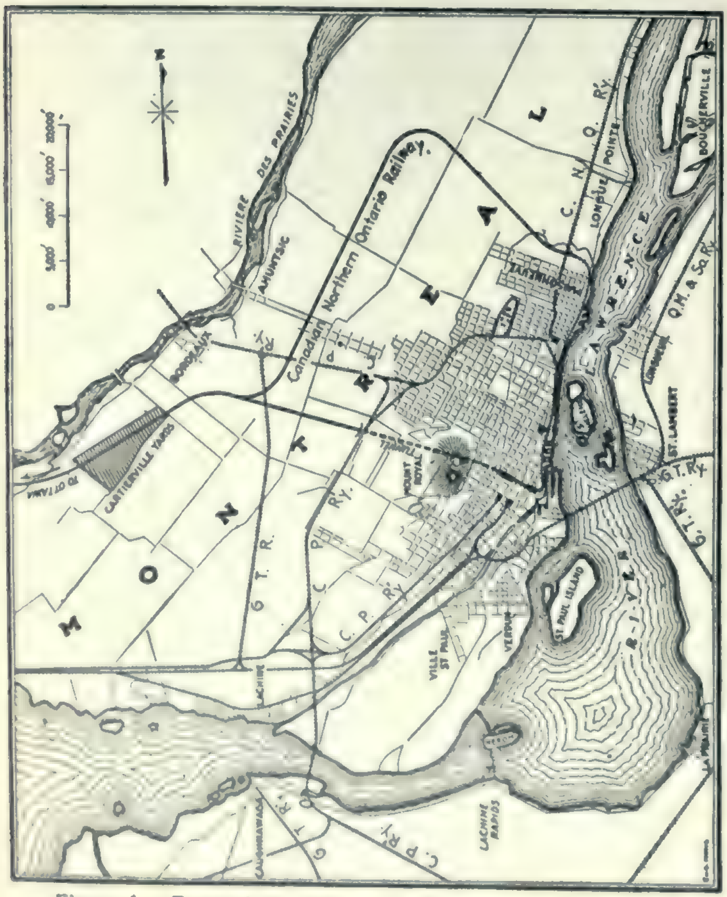


Figure 1.—General plan of terminal connections, Montreal.

Montreal now has a population approaching 800,000, which is increasing at the rate of nearly 10 per cent. per annum. Of this population nearly 75 per cent. is of French extraction. The city is divided into two principal levels—the commercial and financial quarter being on a plain only a few feet above high water, and the residential and shopping district, being on a plateau about 75 feet above the river. In general, the French live to the East and North, while the English-speaking population live in the southwesterly part of the city and on the higher slopes of Mount Royal. As the space between Mount Royal and the St. Lawrence river is very limited, this district has become very congested. Business has largely forced the residence section up and down the river and around the Mountain. An entry from either end of the narrow strip would have been very difficult and expensive in many ways, and, as the Canadian Pacific Railway and Grand Trunk Railway already had lines entering in this manner, no advantage could thus be gained. On the other hand, by tunneling straight through Mount Royal (see Figure 2), the Passenger Terminal could be located in the very centre of the most desirable section, midway between the two levels, and equally convenient to the English and French parts of the city. Furthermore, in the same direct line and without change of grade, the tracks could be carried from the Passenger Terminals across the lower town on an elevated viaduct to connect with the Harbor Commissioners' proposed viaduct; thus giving direct access to the Canadian Northern Transatlantic Steamships, all ordinary harbor facilities and a possible bridge across the St. Lawrence river. Connected with this viaduct an elevated Freight Terminal is planned in the centre of the commercial district, for the acceptance and delivery of local freight.

The Passenger Terminal is located between Cathcart and Lagauchetiere, St. Monique and Mansfield Streets. Its platforms, which are about 1,200 feet long, will be 45 feet below the upper level at Dorchester Street, and 20 feet above the general lower level of the town. Its entrances will be so arranged above and below as to automatically segregate the express from the commuter traffic.

The Terminal buildings (see Figure 3) will be, architecturally, one of the most attractive groups of a commercial nature in Canada. They will, however, be of a purely utilitarian character. It is expected that, apart from the railway business, the income from these buildings alone, will go far towards making the Terminal developments self-supporting.

Much credit for both the conception and realization of this most ingenious entry is due to H. K. Wicksteed, Chief Engineer of Surveys for Mackenzie, Mann & Company, Limited, who, with the principals, conceived the plan in its entirety.

Mount Royal, "The Model City."—Back of the mountains, on the lower slopes, a large tract of farm land was bought, extending northwesterly to the Back, or Ottawa river. Mount Royal, as incorporated, is about one and a half miles in width by two miles, and has not a gully, hill, ravine, nor any low, wet land in the whole town site. The entire property slopes towards the Back river, with an average drop of thirty-five feet to the mile. This Piedmont country was the land so famous for its Montreal melons. It is very fertile and was the most prosperous farming section about Montreal. Its natural drainage lends itself peculiarly to modern municipal sanitation and the geological structures, consisting of solid hard pan only a few feet below the surface, will be invaluable for cheap and easy building foundations. This point is particularly appreciated by people in Montreal who are familiar with the soft and shifting leda clay so common to the city side of the mountain.

Departing from the usual arrangement of having all cross streets run at right angles, the plan provides for diagonal business streets which converge to the central station. This will permit easy and rapid access to the trains from any point. As all public utilities, such as water, sewerage, electric wires, etc., are restricted, where possible, to the alleys, which run through the centres of all blocks, the street pavements will not be continuously broken up and under repair from this source as is so common in the usual city street.

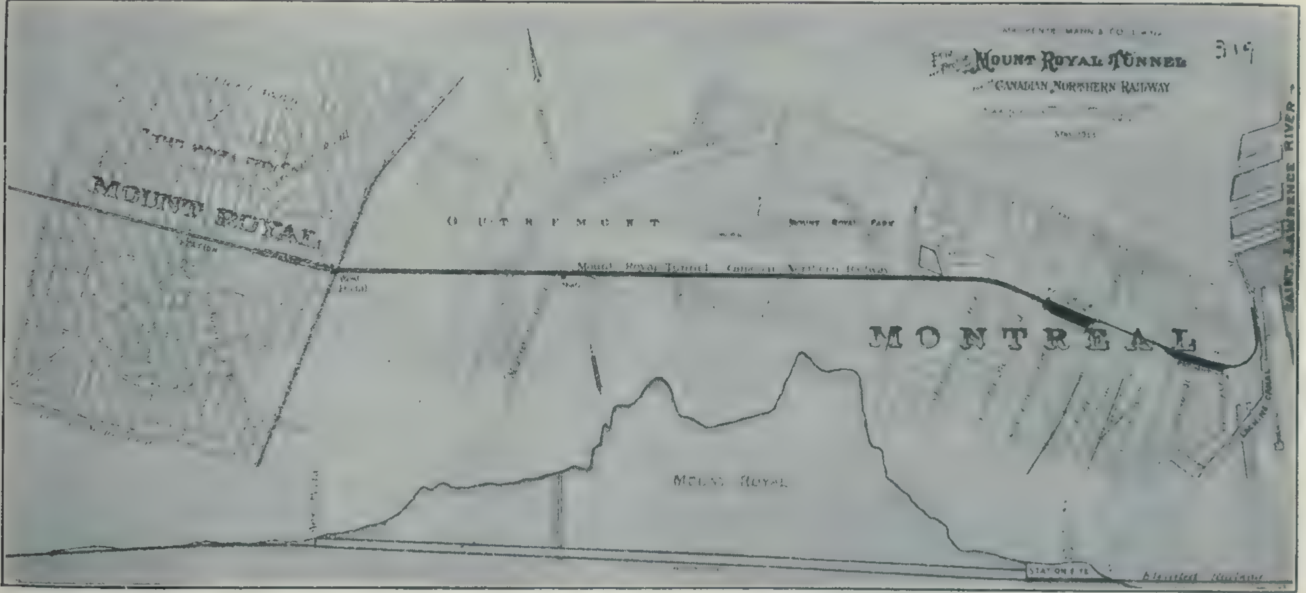


Figure 2.—Plan and profile of Mount Royal Tunnel.

Four streets have been reserved for business purposes, namely:—Graham road, Laird avenue, Canora avenue, and Rockland avenue. These are the only streets where it is possible to erect solid rows of buildings, and it is only on these streets that permits may be obtained for flats and apartments. The balance of Mount Royal will be restricted to high-class residential buildings. Each residence must be at least two storeys in height, built of stone, brick or cement, on stone, brick or cement foundations, at least fifteen feet from the street line; any out-buildings must be at least seventy feet from the street line. Only detached or semi-detached residences will be permitted. Proper restrictions regulating the cost of buildings will also tend to keep the standard high. Each residential street is sixty-six feet wide, and the diagonal business streets are eighty feet in width. The boulevard, which is sixty-six feet in width, encircles the property, and thirteen large parks have been provided. All residential lots are fifty feet wide and vary from ninety-five to one hundred and ten feet in depth. The business lots will average thirty-three by one hundred and twenty feet. A local station called "Mount Royal Heights" will be built where the Canadian Northern line crosses under the Canadian Pacific Railway's belt line, at the west portal of the tunnel. There will be entrances to the station on the Model City side of the C. P. R. The main station, however, back of the mountain will be in the centre of the town of Mount Royal.

Geological Conditions of the Tunnel

Mount Royal, about 700 feet high, is the result of a volcanic intrusion of igneous rock forced upward through the original bed of Trenton limestone. Whether it was ever an active volcano is doubtful, as there is little evidence of lava, although it may have been scoured away by glacial, or other action, at the same time that the higher portions of the mountain were similarly eroded. There have evidently been several stages of eruption or intrusion, as both the limestone and main igneous body of so-called Essexite are broken and cut by a multitude of dikes and sheets of quite different character and evidently later origin. The Trenton limestone, at a considerable depth, is found to be hard and crystalline, and is an excellent rock for tunneling. This rock, when in close proximity to a large igneous body, is sometimes highly impregnated with epidote, quartz, garnet, and other minerals.

At the city end, going west from Dorchester street, the heading for the first 2,000 feet is in a soft black limestone, somewhat blocky and in places partially disintegrated, with occasional stretches of earth roof. The earth, above the limestone, consists of sandy clay, boulder clay, occasional layers of hard pan, fine sand and large bodies of blue leda clay. This being under the city proper, forms the most difficult ground and conditions to be encountered, and a roof shield will be used.

As the rock cover increases the rock becomes harder and more dikes of extremely hard igneous rock, principally Bostonite, Camptonite and Nepheline Syenite are encountered. By the time 3,000 feet of heading had been driven, from Dorchester street, the heading (except for the dikes) was in good, sound Trenton limestone, becoming more crystalline. It was in this that the record progress mentioned later was made.

The Essexite is very hard, containing Plagioclase Felspar, Pyroxene, Hornblend, Magnetite and Nepholine. Aside from this it is a good tunneling rock.

The greatest difficulty encountered in drilling and excavating is due to the irregularity of the structure. Some of the limestone is so impregnated with various contact minerals that it is extremely hard to drill and some breccia is so broken and uneven that in places one hole would be lost out of three started. The worst trouble, however, occurred when large dykes were encountered which necessitated entirely changing the temper of the steel used; for instance, in the heading going east from the westportal a dyke or porphyritic Camptonite, an extremely hard rock, four feet thick, continued in the face for 400 feet. Here two tempers of steel were required in the heading all the time. This greatly retarded the progress and materially increased the cost of excavation.

Another very difficult rock is a marmorized limestone that was found in heading No. 1-W. This marble is impregnated with quartz and a natural cementing material that makes it hard to drill and causes the muck to set up so rapidly that it is very difficult to shovel into the cars.

In general, the Trenton limestone is an excellent tunneling rock although the roof is sometimes inclined to scale badly and where this ground is cut by dykes the tunnel walls are apt to be insecure. When this limestone is badly distorted by neighboring igneous intrusions it is apt to be filled with internal strains which cause it to crack and fall making it rather treacherous and requiring heavy timbering and masonry lining.

Often, especially in the limestone, cavities are found filled with calcite crystals of both the dogtooth and nailhead pattern. Here too, is found a good deal of saponite and pyrites in various forms. Considerable Dawsonite, Feldspar, metallic arsenic and gypsum have been found from time to time, but not in quantities to be commercially valuable.

Tunnel Location

The location of the tunnel under Mount Royal was established more or less by the location of the passenger terminal in Montreal and the "Model City" at the back of the mountain. For many reasons, a tangent from the central station in the "Model City" to the passenger terminal in Montreal would have been most desirable. But as this would have necessitated passing under much valuable property with very light cover, it was thought best to abandon it. This line would also have passed through a large body of Nepheline Syenite, which is a very hard rock.

It was known that the heart of the mountain was a hard igneous Essexite, as above described, and that Camptonite breccia outcropped near the west portal. While this lower ridge of breccia and hard rock could not have been avoided without seriously affecting the layout of the "Model City," a portion of the hard rock in the centre of the mountain could have been avoided had it been considered expedient. The line finally adopted is 3 1-10 miles long and is the shortest line possible between the two main objective points, that could be devised to avoid surface obstructions and take advantage of the geological formation. This gives, economically, an extremely good tunnel line, which (with the exception of one curve under the McGill University grounds) is all on a tangent and has only sufficient grade (0.6 per cent. down toward the city) to insure proper drainage.

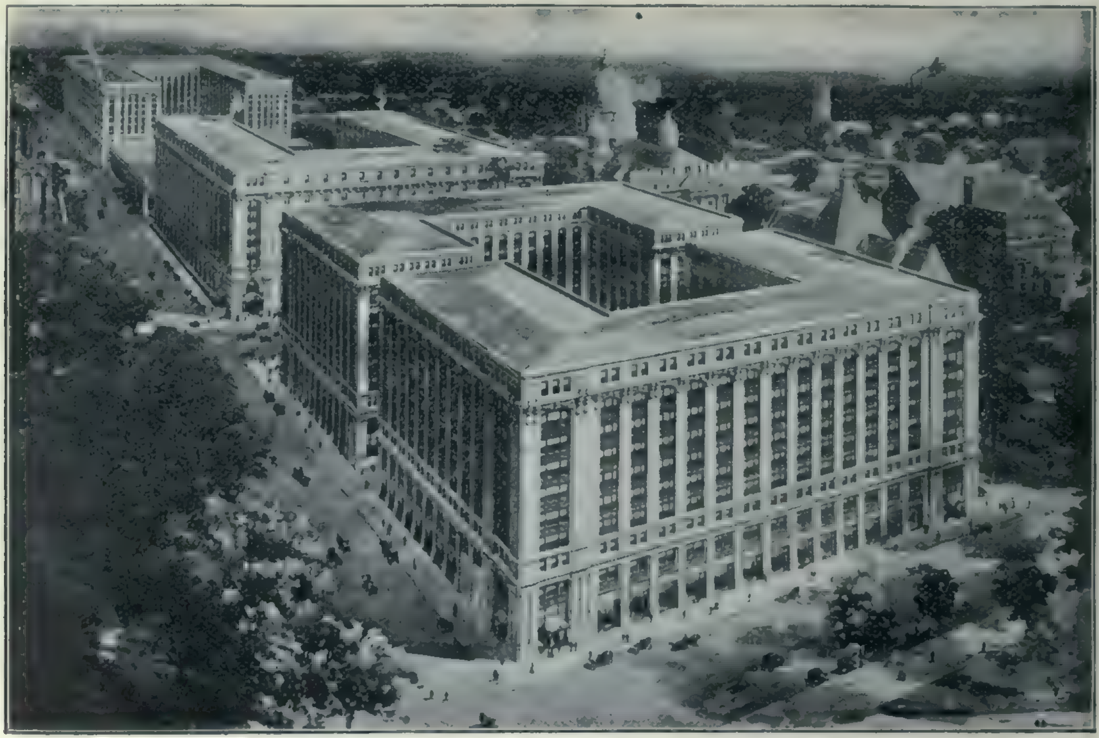
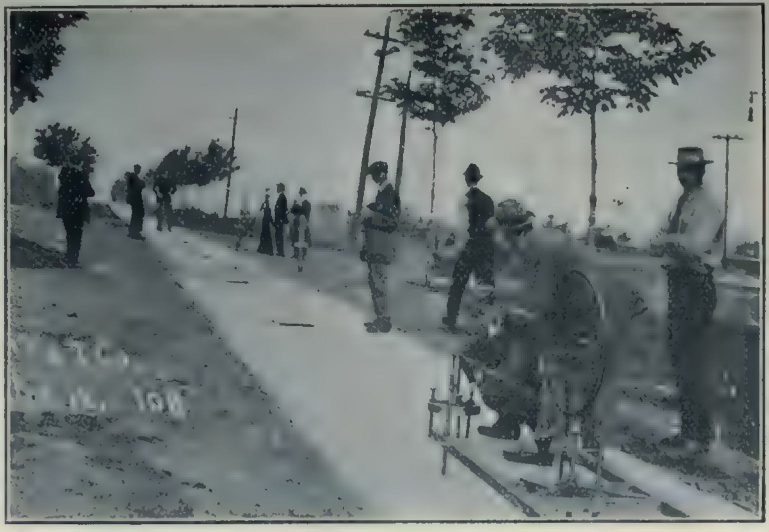


Figure 3.—Proposed buildings for Canadian Northern Passenger Terminal. Messrs. Warren & Wetmore, architects.

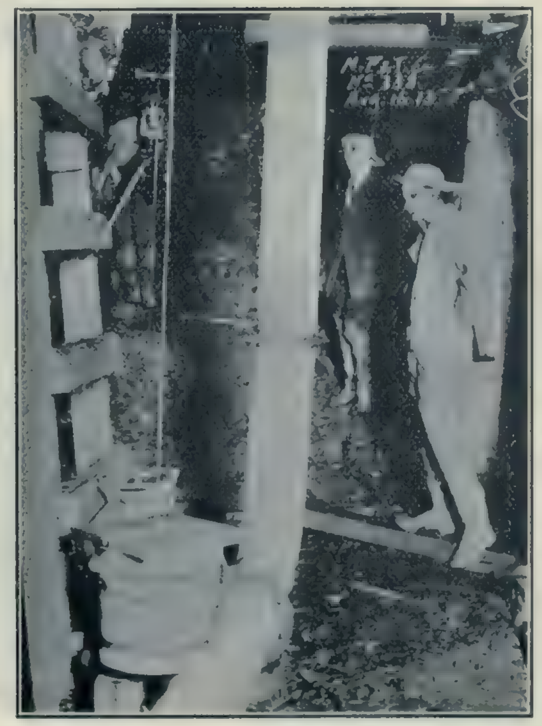
Surveys and Alignment.—Tunnel surveying is interesting, principally on account of the accuracy required and the many opportunities for the exercise of ingenuity. It consists primarily of definitely locating and mapping all the topographic features in the imme-

A—Igneous dykes in Trenton limestone. After the Mountain had been shattered by an eruption, this trap flowed into the cracks forming the dykes,

B—Camptonite Breccia. The black rock in this conglomerate is Camptonite Trap which has flowed about the shattered limestone marmorizing it by the terrific heat, the white rock being marble.



A—Measuring.



B—Shaft plumbing.
Figure 5.—ALIGNMENT SURVEYS.

diate vicinity of the proposed line. Upon the maps thus prepared, the best positions for the openings such as shafts and portals can be fixed upon, the best underground route for the tunnel laid down, and the design of its construction determined.

The alignment parties give the direction for excavation and all points for placing the construction. In order to get the true direction and distance from one opening to another it is necessary to have their position on the ground accurately determined. This requires careful measurement and angle reading. As the work progresses the calculated courses and distances between the shafts or portals are placed in the openings and the direction in which to excavate shown to the rock drillers. Careful steel tape measurement is often called base-line measurement, as many base lines for triangulation work are determined with the same methods. The careful measurement was made in this case along the paved streets on the north side of Mount Royal. On this work the steel tapes used were compared with a special tape standardized at the Bureau of Standards in Washington, D.C., at a given tension and temperature. In the surveys the readings were always taken at the standard tension and corrections made for temperature. The tapes were stretched across movable brass headed monuments, called spiders, set upon transit lines. The levels of the spiders were taken to correct for inclination. The standard tension in the tape was maintained by a standard weight suspended over an inverted bicycle wheel (see Figure 5). The tape was supported every 20 feet, which was also standard. After the traverses had been completed a transit line was thrown over the mountain on the tunnel tangent line as a check with very satisfactory results.

After the places of entrv had thus been located, and lines in the vertical planes of the tunnel axes had been established, points were fixed from which sights could be projected directly into the tunnel. The lines were projected down the shafts by means of heavy plumb-bobs suspended on fine piano wire. These wires were lined up at the top of the shafts from the fixed points on the surface line and at the bottom the direction was taken off the wires and projected into the tunnel. The plumbs were suspended in tubs of water and oil to retard osscilation. In the present case this work was somewhat more complicated than it sometimes is, on account of the necessity of locating the shafts on the company's property, which was not directly over the tunnel. This made some sharp curves and short sights in the headings at the foot of the shafts to get to the tunnel line.

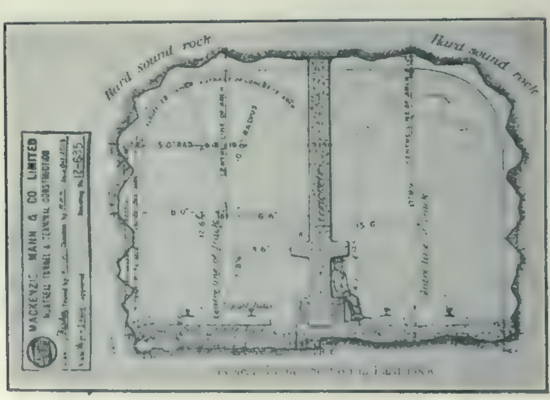


Fig. 6.—Tunnel cross section in hard sound rock requiring no lining.

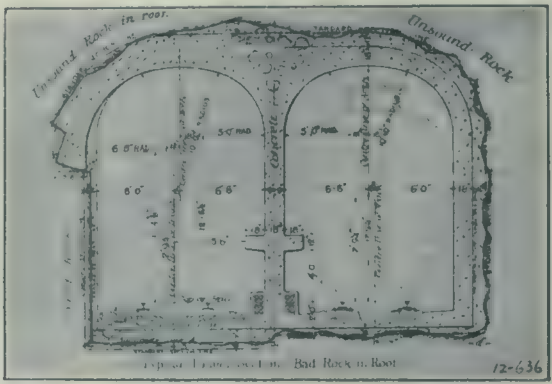


Figure 7.—Typical tunnel section, bad rock in roof.

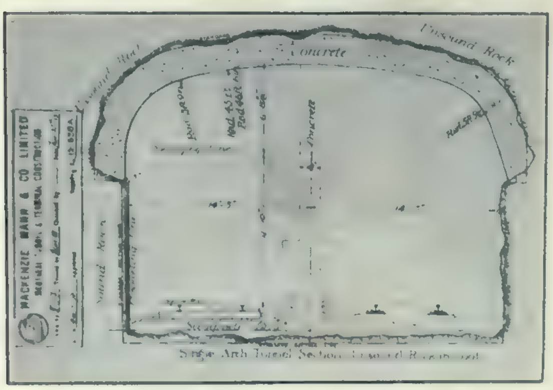


Figure 8.—Single arch tunnel section, unsound rock in roof.

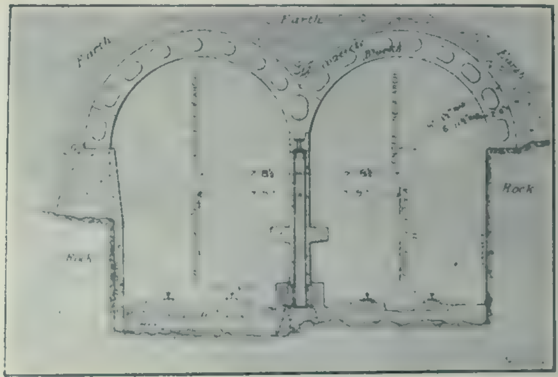


Figure 9.—Tunnel cross section in very soft ground, requiring shield, concrete block lining.

Heading on Centre Line of Main Tunnel

The primary excavation consists of a heading, or small tunnel, about 9 feet in height by 12 feet wide, driven on the centre line of the main tunnel, which is about 22 feet high by 30 feet wide. As this is a bottom heading, i.e., driven along the sub-grade of the tunnel proper, the permanent monuments are placed in the bottom of the heading, where they will not have to be disturbed. Only temporary wooden plugs with steel spads, i.e., nails with perforated heads to suspend sighting lamps on, with occasional brass vernier scales are placed in the roof. The plugs with spads are placed about every 50 feet in the heading on the engineer's line, and by knowing the relation of this line to the tunnel centre-line, and the various elevations of the spads, the alignment and grade of the heading may be maintained with considerable accuracy.

In all tunnel surveying, patience and continuous repetition is the key to success. All lines must be checked and re-checked, and readings made again and again by the independent observers, so as to rectify errors and produce the greatest accuracy possible. This is especially important in the underground work where no outside check can be obtained until the headings meet.

The methods just described have worked out very satisfactorily in the present case. The Maplewood avenue shaft is one mile from the west portal. The shaft is about 240 feet deep, and the plumbing wires were only 13 feet apart. The shaft is off line and requires short reverse curves in transferring the lines from the shaft to the tunnel. When the heading coming from the west portal met that being driven from the Maplewood avenue shaft, on April 5, 1913, the lines checked within 1-16 inch in alignment and ¼ inch in grade. Where the headings between the Maplewood avenue shaft and Dorchester street shaft met, under the highest point of Mount Royal, on December 10, 1913, the error was about three-quarters inch in line and one-quarter inch in grade.

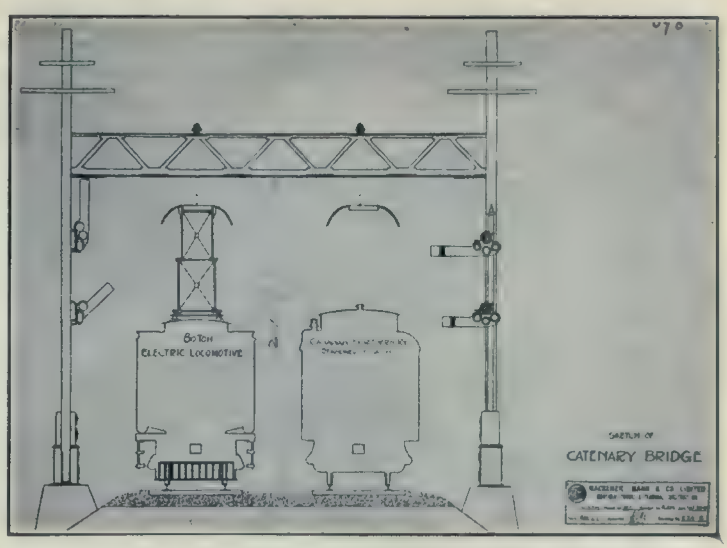


Figure 10.—Outside bridge construction for contact circuit.

Tunnel Cross-Sections

The types of tunnel cross-section finally adopted, while bearing many points of similarity to various other tunnels already in existence, have a few novel features that are believed to be a step in advance in that particular branch of railway engineering. In the studies for this design, the maximum equipment of American roads was summarized, and actual clearance and equipment diagrams of many of the most representative roads were studied and superimposed. In this manner a diagram of minimum clearance and a diagram for maximum equipment were evolved, for all cars likely to pass through the tunnel. It was found that a few freak cars, of exceptional width, had to be eliminated, but these were very few, of a class not likely ever to appear, and which had not been allowed for on other important roads.

A twin section was chosen for three primary reasons: (1) economy in construction; (2) ease and economy in ventilation; (3) protection and safety in case of derailment or accident.

1. Economy in Construction.—It was found that in soft ground the amount of both excavation and masonry could be reduced by adopting this twin section. The geological formation also indicates that in much of the rock, cut at the angle made by the present tunnel location, a centre wall will sufficiently reinforce the natural rock roof slab to eliminate the necessity of further lining without excavating a high rock arch.

2. Ventilation.—It is needless to say that a twin tunnel with all the traffic in each tube going in the same direction, is infinitely better for ventilation than a double track tunnel, where passing trains merely tend to stir up the air, without causing any positive and continuous movement in any one direction. The cross-section of each tube is so proportioned that the relation of train area to tube area will materially encourage ventilation without producing excessive compression, which would retard the velocity of trains and might be objectionable to passengers.

3. Safety.—The centre wall is particularly valuable in case of derailment or accident, there being no possibility of trouble on one track blocking both. Furthermore, having a walkway at about the platform level, it is possible for passengers to get out of the cars, in natural and orderly fashion, in case of stoppage and walk to the nearest cross passage, wher they can enter the adjoining tube. This walkway is made narrow so that people must pass along in single file, the idea being to avoid the danger of crushing and panic.

The normal clearance at the walkway edge is 2 in. greater than that of the normal high passenger platform adopted in the terminal station, and 3 in. greater than that allowed on the New York Central R. R. and Pennsylvania R. R. lines about New York. The walkway edge also coincides with the clearance lines (outside of platform) of the Pennsylvania R. R. (lines east of Pittsburg), including the through lines between New York and Pittsburg.

Underneath the walkway is a continuous refuge niche, except at splicing chambers, where trackmen may sit on the duct bench, at the bottom of the dividing wall, and be absolutely protected from passing trains. Large refuge niches will be built occasionally in the outside wall for the accommodation of hand cars and repair equipment during hours of train operation. The outside wall clearance is coincident with the clearance for new structures in the New York Central R. R. terminal work in New York, and is in excess of the clearance of the Pennsylvania R. R. lines east of Pittsburg.

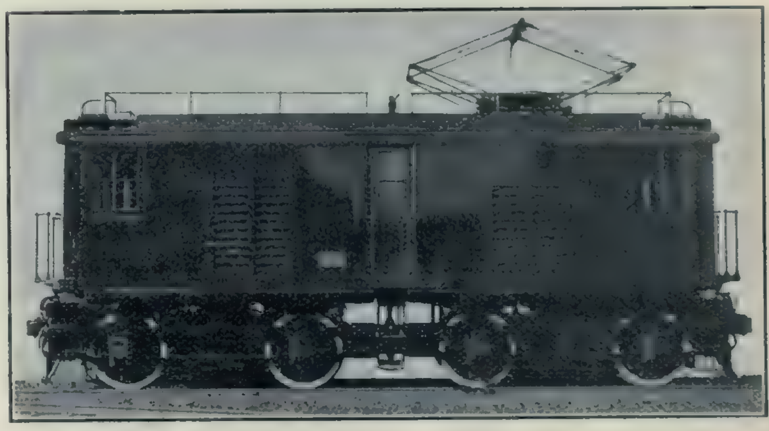


Figure 11.—80-ton, 2,400-volts, direct current, electric locomotive, to be used on Montreal electrification.

A high headroom was adopted as provision for a high-voltage trolley. The flattened three-centre arch was adopted: (1) to allow for the sway of the pantograph; and (2) on account of the stratification of the rock, where much of the lining will occur, which lends itself peculiarly to a flat roof (see Figures 6 and 7). In the soft ground on the city end, where a roof shield is to be used, twin semi-circular arches will be used slightly higher and wider than the standard section. This change in shape and size was adopted on account of ease and safety in construction. (See Figure 9.)

The floor and track construction will be of two types: (1) creosoted ties, with tie-plates and screw spikes, laid in a deep trough of ballast; (2) a fixed grade and alignment, produced by rail supports rigidly fastened to a concrete bed. The former, used under the city proper, is designed to produce the least possible vibration. The latter type being for stations, and in the major part of the tunnel, is designed for small maintenance cost with perfect grade and alignment.

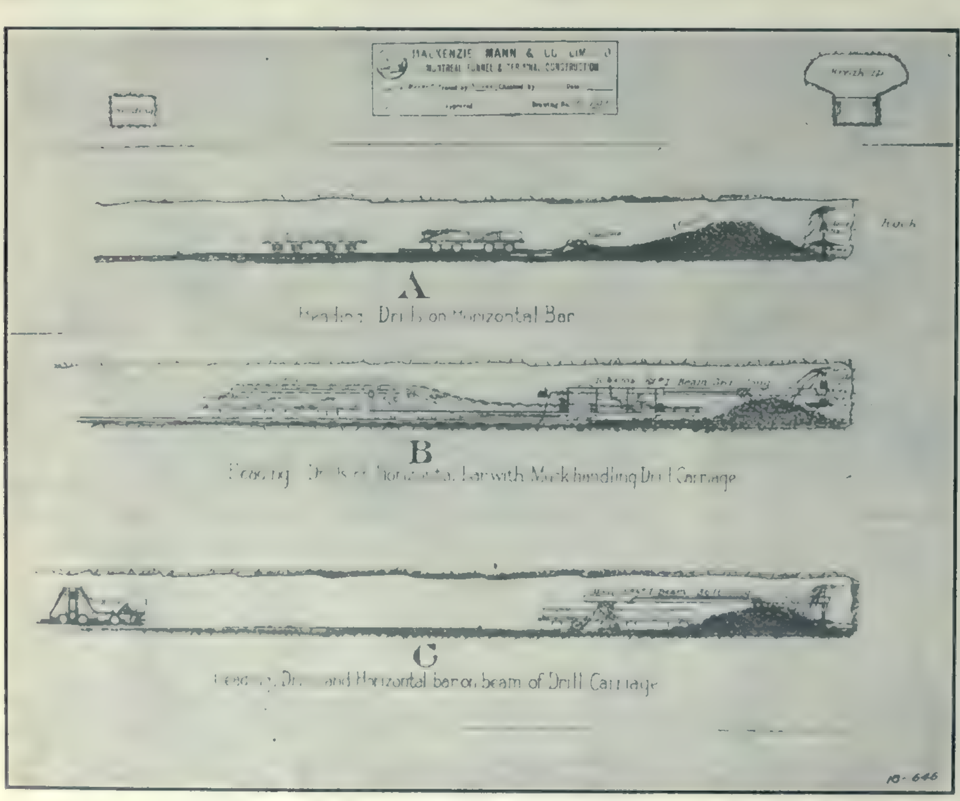

MACKENZIE MANN & CO LIMITED
MONTREAL TUNNEL & TERMINAL CONSTRUCTION
Rock
A
Heading Drills on Horizontal Bar
B
Heading Drills on horizontal bar with Mack heading Drill Carriage
C
Heading Drills and Horizontal bar on beam of Drill Carriage
10-646

Figure 12.—Typical heading procedure.

The general cross-section, as above described, will vary materially, in certain details, with the character of the ground through which the tunnel passes. Where the roof is bad, and the sides are in good rock, the sidewall concrete may be omitted, where the rock caves in the roof a double track arch may be used (see Figure 8). As the work is being done by Mackenzie, Mann & Company, Limited, who control the Canadian Northern, with one organization for both design and construction, every flexibility in design may be taken advantage of for economy in construction.

Electrification

All trains through the tunnel will be operated electrically. Locomotives will be used to haul Transcontinental, Express and Local traffic, which extends beyond the "Electric Zone," and multiple unit motor cars will be used for the traffic inside the boundary. The locomotives are 80 ton (see Figure 11) and capable of producing a speed of 50 miles an hour. The heaviest trains will be 16 car Transcontinentals, the rated speed being 30 miles with two locomotives. The Multiple unit cars are 60 ton cars with a speed of 45 These cars can also haul one trailer if desired. All steel cars will be used.
miles per hour and a seating capacity of 70 passengers.

The power used will be 2,400 volts direct current. All motors are wound for 1,200 volts and insulated for 2,400 volts, and are operated two in permanent series. The contact circuit will be of the overhead catenary type, the character of the climate making a third rail inadvisable outside the tunnel. (See Figure 9.) A sub-station for power conversion will be built near the west portal of the tunnel. If the company develops its own power, or buys its power, where there is doubt of continuous service a steam auxiliary plant will be built near the Back river. Near the Back river, too, will be the Cartierville Yards where most of the freight will be sorted and the transfer made from steam to electric traction. Here also complete repair shops will be erected. The signals will be of the automatic block type with a special safety device by which a train is automatically brought to a stop if the engineer inadvertently runs by a block signal that is set against him.

On the Multiple unit cars special safety appliances are arranged so that if the motorman collapses for any reason, the train is brought automatically to a stop, and by certain door connections no train can start until all doors are closed.

Excavation and Construction

There are many methods of tunneling, usually known by the name of the country in which they originated or have been most commonly applied. The so-called American method is the top heading and bench method, where a small tunnel or heading is driven in the upper half of the tunnel section and the bottom portion or bench is removed later, often with a steam shovel, where the character of the ground permits. This is often very economical and has many points of advantage over other methods where the ground makes it advisable, but it is not as fast as some of the European methods, which have been developed for long tunnels where time was of very great importance.

Time being of vital importance in the Mount Royal Tunnel it was decided to adopt a bottom centre heading which could be driven ahead rapidly, without much regard for the character of the ground, and from which the full-sized excavation could be developed at as many places simultaneously as desired.

Heading Excavation.—The headings are driven 8 to 10 feet high by 12 to 14 feet wide (over 50 per cent. larger than the headings of the principal Alpine tunnels) for the sake of ultimate economy. While this somewhat reduces the rate of progress, it very much decreases the cost of further excavation and construc-

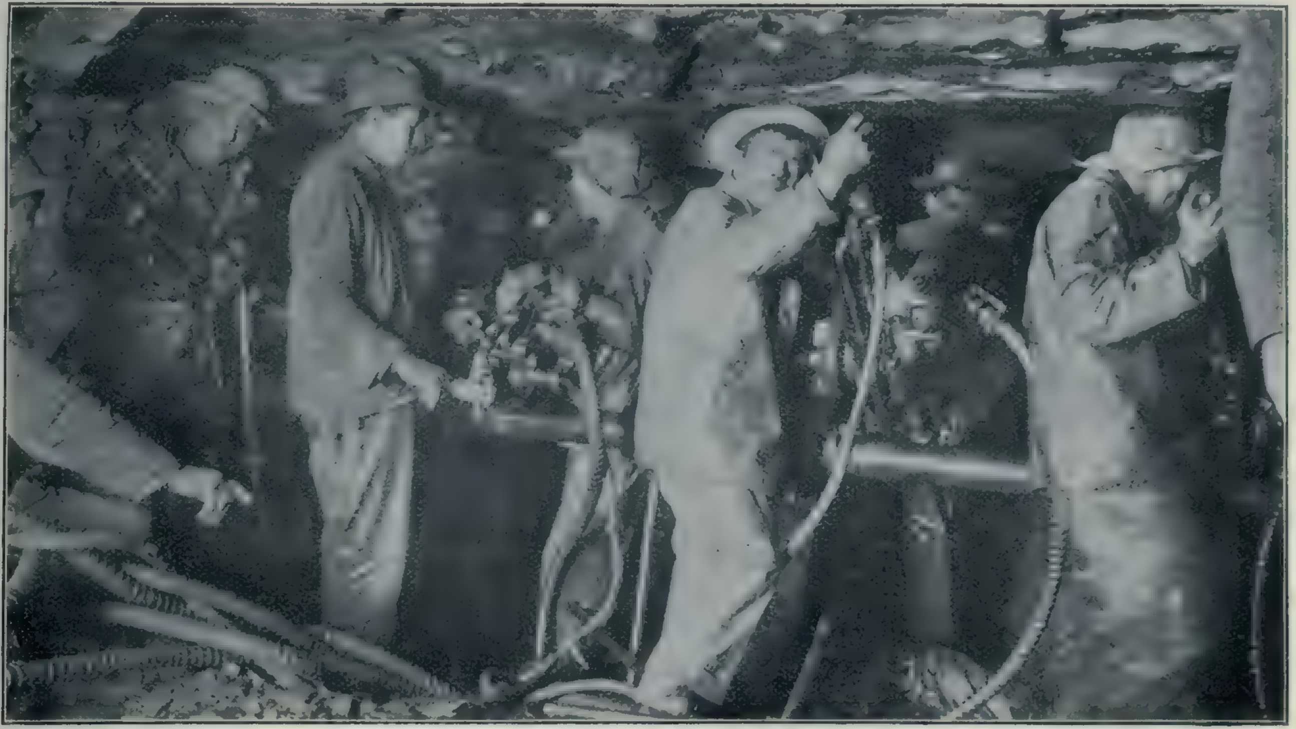


Figure 13.—Heading excavation without drill carriage.

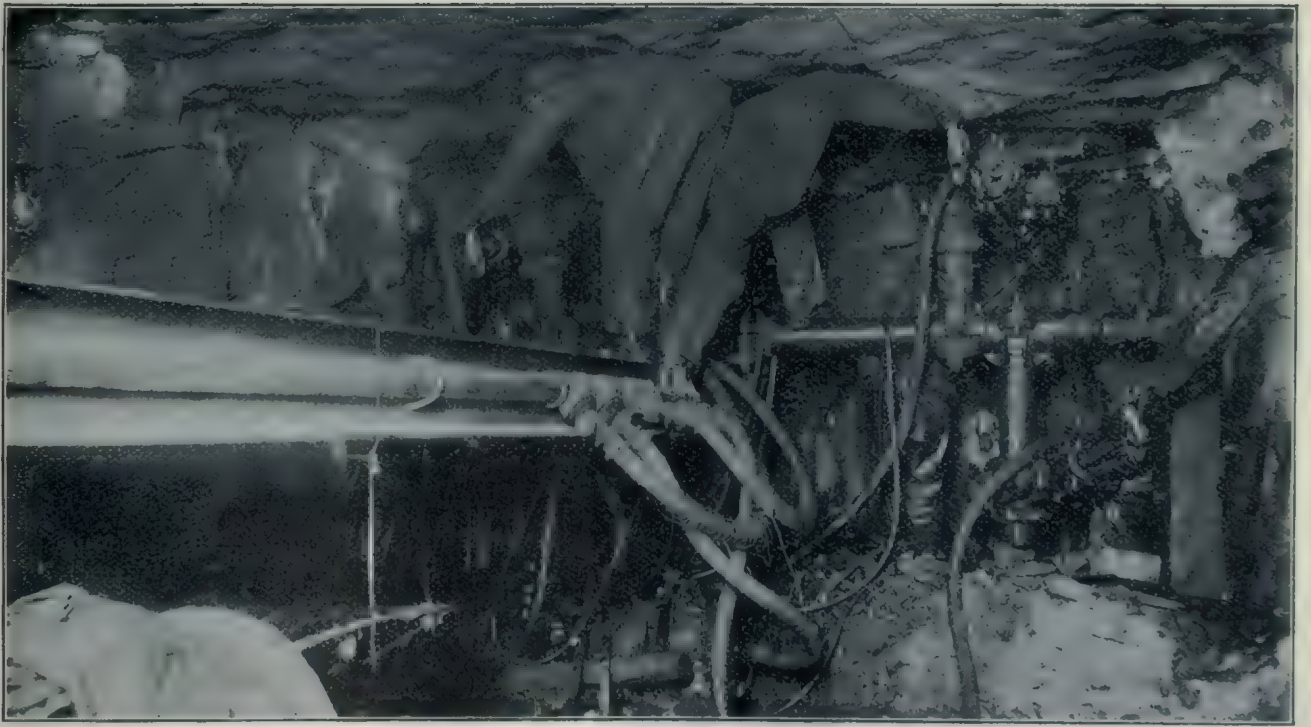


Figure 14.—Heading excavation using muck handling drill carriage.

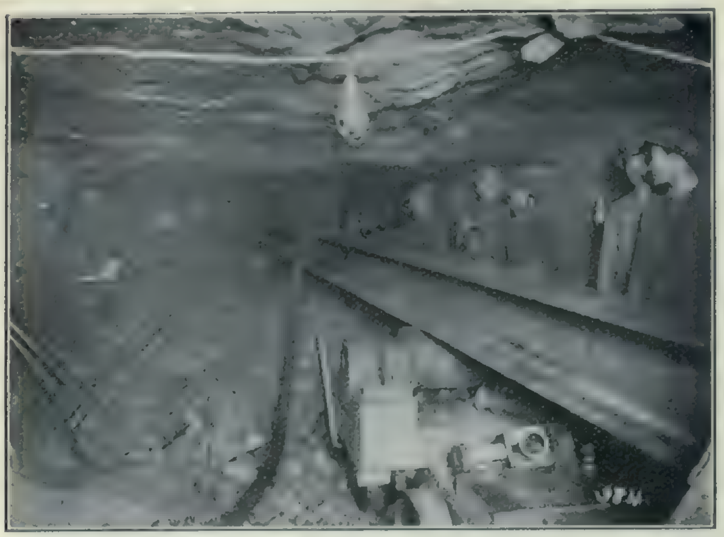


Figure 15.—Heading excavation using drill carriage without conveyor.

tion; permitting reasonably broad-gauge double track through the break-ups, where the full size tunnel section, 22 feet high by 30 feet wide, is developed.

In the headings three principal methods have been used (see Figure 11). "A" Figure 12 shows the method where the rock was not so hard as to require an excessively heavy drilling equipment. The drills are mounted on a horizontal bar and the equipment is handled in and out of the heading by hand. During this stage at the city end the heading cross-section was reduced to about 8 by 12 feet for the sake of rapidity in progress. (See Figure 13.) Here no drill carriage was used, as much lighter drills were required, and a progress of 810 feet was made in the 31 working days following May 1. This is the greatest linear progress ever made in a hard rock heading on this continent and has only been exceeded in Switzerland. Four drills are used in each heading, supported on a horizontal bar. These drills are operated by compressed air at about 100 lbs. pressure per square inch. Each drill is fitted with special connection so that water may be forced through the piston and drill steel, which are hollow, into the bottom of the hole being drilled, thus keeping it cool and clean. It is also interesting because both the linear feet of drilling (about 650 feet per 24 hours) and cubic yards of excavation (93 cubic yards per day) exceed anything ever accomplished in the European tunnels.

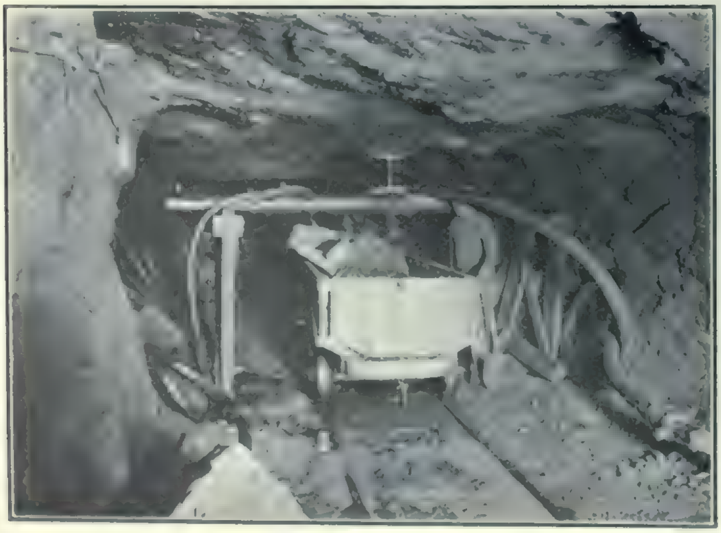


Figure 16.—Heading excavation, rear end of cantilever beam of drill carriage without conveyor, carriage removed for mucking and drilling in operation.

As the headings got into the hard igneous rock heavier drills were required, so that the total drilling equipment, including drills, saddles, arms and bar, weighed several tons. To carry this mass two types of drill carriages were devised (see Figure 12). Each carries the drill bar on a long cantilever arm having a reach of over 20 feet beyond the carriage and is so arranged that the drills never have to be dismounted from the bar nor disconnected from the hose-manifold which is fastened to this cantilever arm. Thus the only connections to be made, when moving out or setting up, are the main air and water hose to the pipe lines entering the heading, and the only labor is that of jacking the horizontal drill-bar tightly into position after it has been brought in and placed by the drill carriage.

All drill carriage track is riveted to steel plates so that the track may be cleared rapidly to within about 25 feet of the face after each shot, merely throwing the muck right and left. In the case of the muck-handling drill carriage the track is laid on one side of the heading while the other has its track down the centre. These machines save wear and tear on both men and machines, and made a surprising difference in the efficiency of both. With these machines the drills are in the heading ready to be jacked into place by the time the drillers have the loose rock barred down from the sides and roof and the muck thrown back sufficiently from the face to enable the bar to be set. Thus the time spent in setting up and taking down is much reduced. It is also notable that less muckers are required with this system than before the drill carriages were installed.

One drill carriage (see "B" Figure 12) is so designed that the cantilever arm is given its motion, longitudinally, transversely and vertically by motor-driven attachments. This machine remains in the heading after the drills are placed and has a bent conveyor running through it longitudinally, about 18 inches above the track, which elevates and dumps the muck into cars in the rear. This was used in heading N. 3-E (see Figure 14).

The effect of installing the muck-handling drill carriage is shown to a remarkable degree by the difference in progress obtained without any increase in force. For the six months prior to its installation the average progress in this heading was 350 feet per month. For the six months after the installation of the drill carriage the average progress has been 183 ft. per month. This is an increase of 38 per cent. Furthermore, it must be remembered that before the drill carriage was installed the heading was in limestone, for the greater part, while the drill carriage has been working almost exclusively in Essexite. The best month, May, 1913, was 510 feet in 27 working days. This heading is 10 feet high by 12.5 feet wide. The average yarding removed from this heading, including the 4 break-ups now working, is about 500 cubic yords, place measurement, per day. The linear progress in these break-ups is about twice that of the heading.

The other drill carriage used in heading No. 1-W (see Figure 15) has no motor attachment and is removed from the heading after the drills are placed (see "C" Figure 12) leaving the cantilever arm attached to the drill bar and supported on a gallows frame which leaves the heading open for mucking (see Figure 16). In this case the cantilever arm is advanced by the locomotive which pushes the drill carriage into the heading. The lateral and vertical movement are obtained by jacks and by hand. The progress with this carriage is almost identical with that of the other. The average progress over the entire job since the headings were started in the tunel has been 420 feet per month in each heading. This makes no allowance for delays or lost time. It must also be remembered that for six months on the city end the blasting was restricted between the hours of 11 p.m. and 7 a.m. to avoid public annoyance. The average progress, where blasing has been unrestricted, has been 430 feet per month in each heading. From the time the first heading was started in the tunnel until the final meeting almost exactly fifteen months have been elapsed, giving a gross progress of 1,100 feet per month.

The general heading procedure is as follows:—

After a round of blasts has been completed the loose rock is barred down from the roof and sides and the muck (i.e., the broken rock) is thrown back from the face sufficiently to permit the horizontal bar and drills to be set up. These are erected, connected with the air and water lines and drilling commenced. From 18 to 24 holes, 5 to 8 feet deep, are drilled in the heading. In the meantime the muckers have cleared the tracks, and are shovelling the muck into the cars, or onto the conveying belt where the muck-handling drill carriage is used. Smooth steel plates, called slick sheets, are laid in the bottom of the heading to fall on, so that the muckers shovel oc a smooth surface.

Where no drill carriage was used (see Figure 13) three muckers threw muck back from the face to the slick sheets and four shovelled it into the cars. These four men, one each shift of 8 hours, handled all the muck made in that shift. Thus, during the record month, each man handled from 12 to 15 cubic yards of muck per shift, which, considering that about two hours of each shift were lost in blasting, was a most unusual performance.

All blasts are fired electrically from the lighting current; the blasting switch and leads being carried on the opposite side of the heading from other electric wires. Where time fuses are not used the rounds are usually fired in four shots; 1st, the cut holes, which form the opening wedge; 2nd, the relieving holes, immediately surrounding the cut; 3rd, the line holes, which break the heading to its full width; 4th, the dry holes, which break the heading to its full height. Sometimes the line holes and dry holes are fired together when the ground is breaking well. Where time fuses are used, the cut is fired in the usual way with ordinary exploders so that if, as is very often the case, the cut does not break to the bottom at the first shot it can be fired a second time.

After the cut has been fired the rest of the heading is loaded with time fuses, cut at two inch intervals, running in length from two inches up. Two of each length of fuse are used around the cut, the shortest fuses being closest to the cut and the longest being the two bottom corner holes so that the muck will be thrown back from the face by the last explosion. These fuses are ignited by electric igniters exactly similar in construction and resistance to the regular electric exploders. Thus all fuses are ignited simultaneously and regular exploders may be discharged at the same time if desired. This method saves time in blasting and leaves the men much fresher than if they had to go back into the smoke again and again. As all the fuses are very short the danger from cut-off holes is practically eliminated; in fact there has been no trouble from this source whatever thus far. This method is also used in all the break-ups.

In the heading a round of shots is fired from 3 to 6 times a day (24 hours). During the record month, with three exceptions, six shots were fired every day.

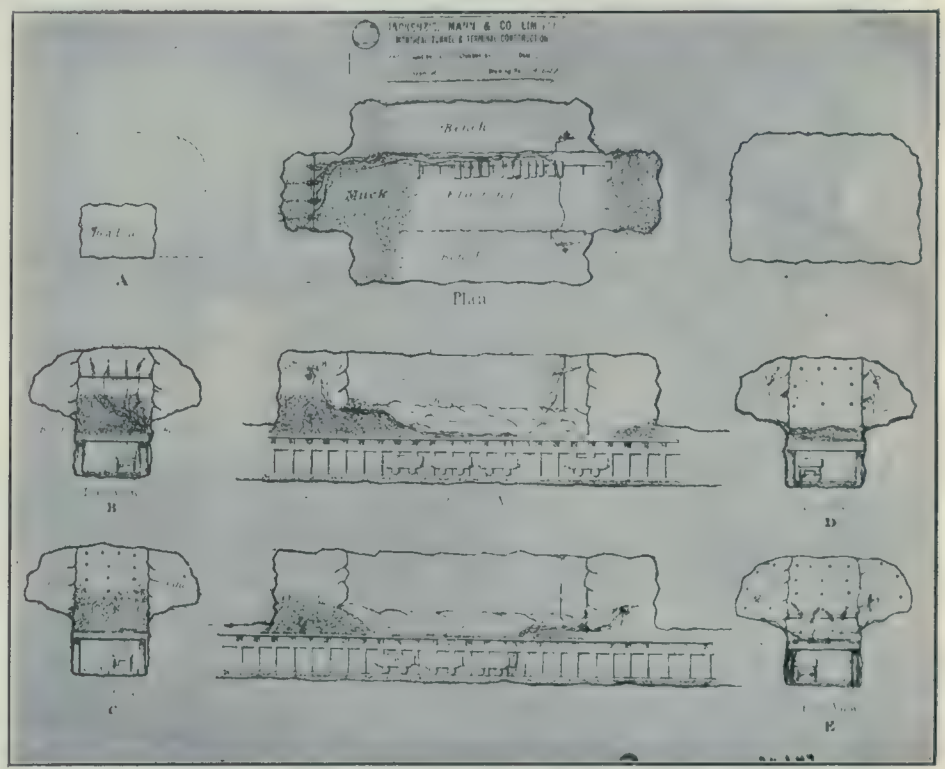

MACKENZIE, MANN & CO. LIMITED
MONTREAL TUNNEL & TERMINAL CONSTRUCTION
Bench
Muck
Plan
A
B
C
D
E

Figure 17.—Typical break-up procedure.

Break-up Excavation.—The break-ups (see Figures 17 and 18) where the upper part of the tunnel section is excavated to its full width and height, are opened at intervals of 500 to 800 feet along the centre bottom heading. As many of these may be opened as are necessary to keep up with the heading progress, the advance in each break-up being about half that in the heading. In making the break-up excavation heavy jumbo timbers are framed into the heading, about two feet apart and planked over, so that as the rock is blasted down from above, it can be run through the jumbo timbers into the muck cars in the heading beneath.

In Figure 17, "A" shows the location of the heading in the tunnel section. The break-ups are advanced by carrying an entry, about 15 feet ahead of the wing wall excavation, the same width of the heading and to

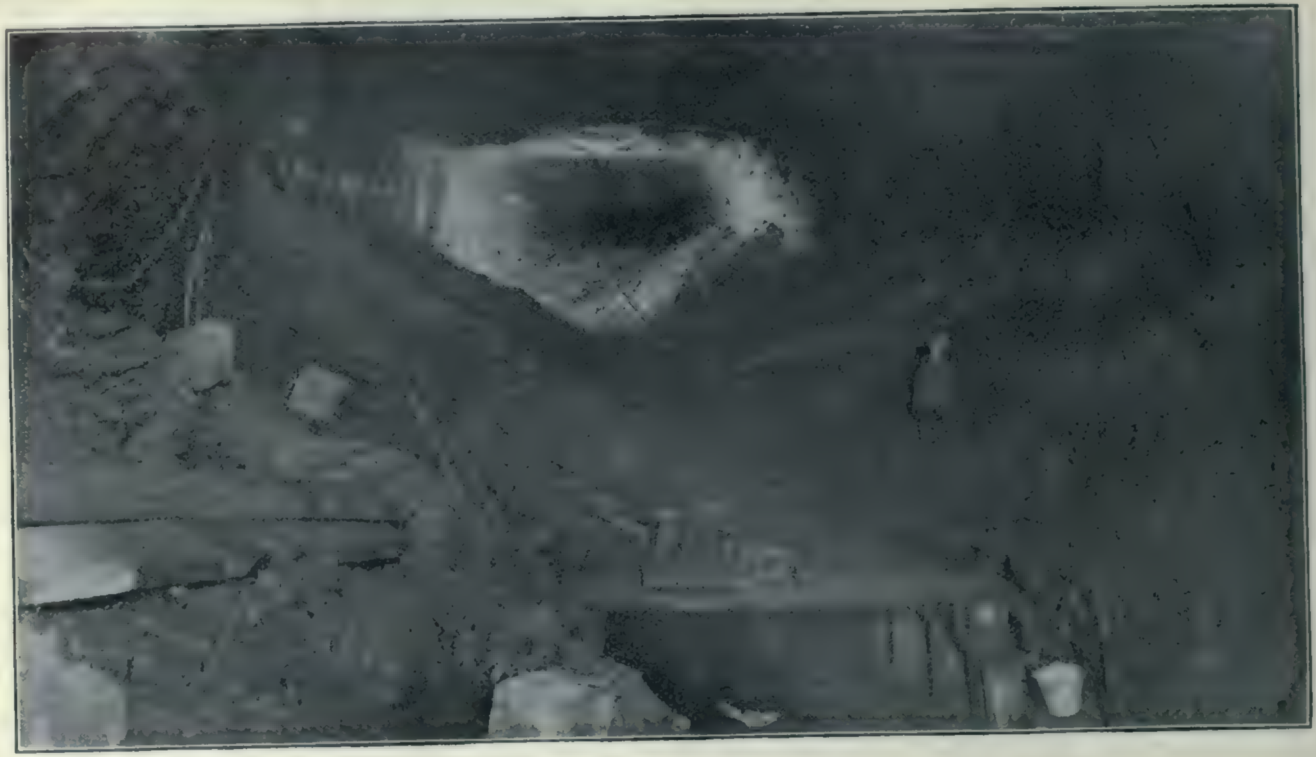


Figure 18.—Break-up excavation, showing bottom heading with jumbo timbers.

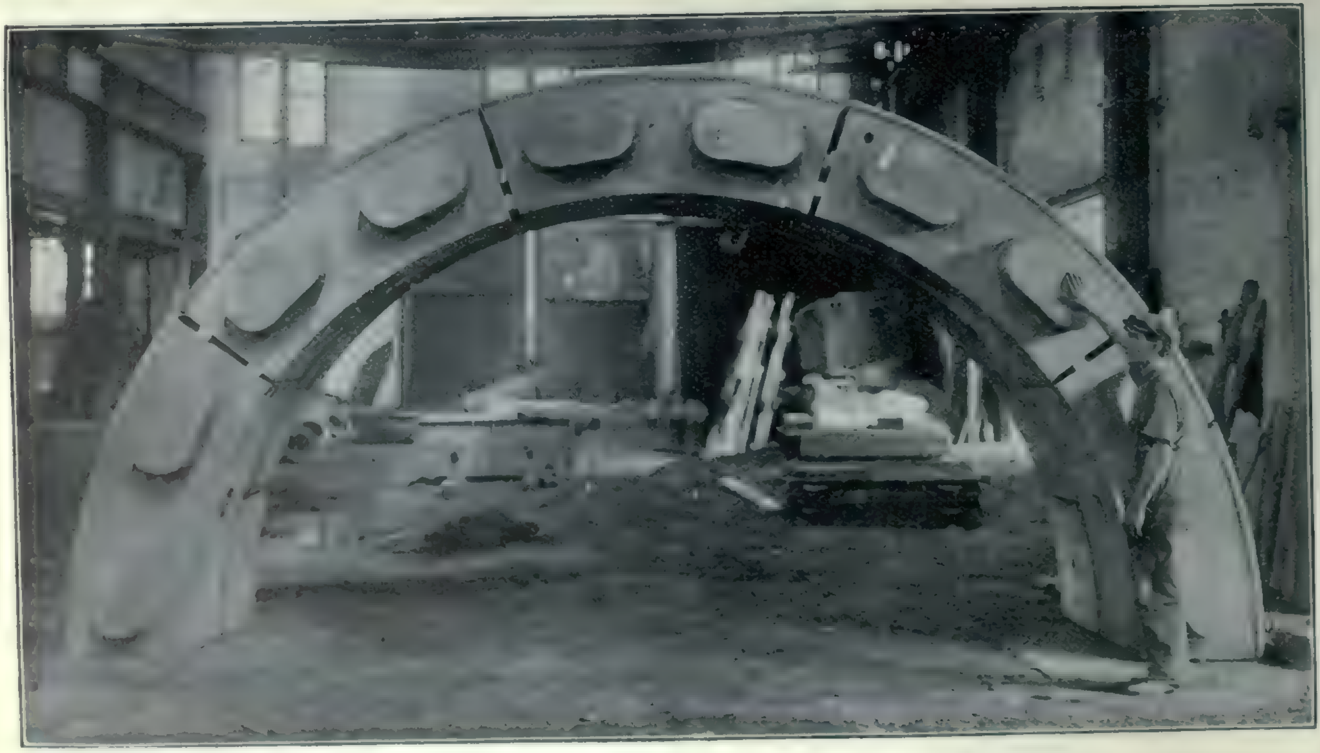


Figure 19.—O'Rourke concrete block arch, set up in shop, showing tenons.

the full height of the roof. As seen in "B" figure 17 a horizontal bar is used with 4 drills as in the heading. Immediately after shooting the bar is set up above the muck and the upper half of the entry is drilled. Then the bar is removed to the other end of the break-up, and while the upper half of that entry is being drilled the muck is removed from the first entry. Thus when the upper half of the second entry is drilled the bar may be set up again in the first entry and the lower half drilled (see "E" Figure 17). By the time this drilling is finished the muck is removed from the second entry and the lower half of that may be drilled. In the meantime two columns with a single drill on each are set up in the wings and these drilled so that all the drilling is finished at the same time.

In the limestone two drilling shifts will break all the ground that three mucking shifts can handle economically. As the blasting is always breaking to two faces the drilling is comparatively light and very little powder is required; the powder actually amounting to less than one quarter that required in heading work.

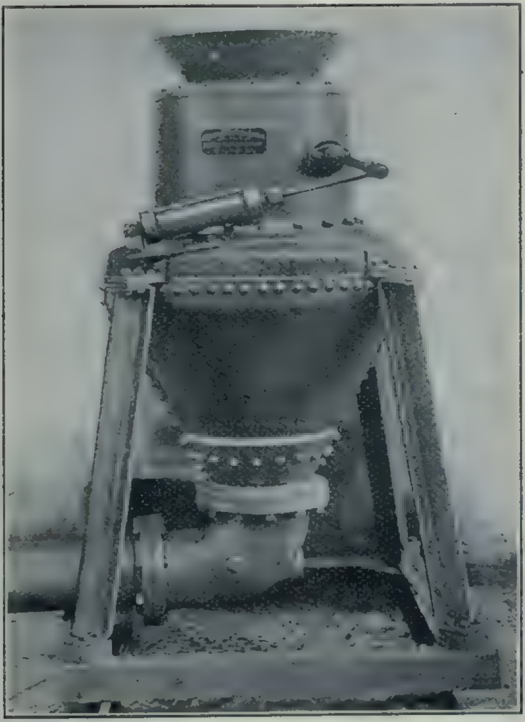


Figure 20.—Pneumatic concrete mixer.

The blasting in the breakups is done with time fuses which are ignited electrically, as already described. Thus it will be seen that the Break-up Excavation requires but little labor and explosive, being both rapid and economical. With four break-ups and one heading working at the back of the mountain the average excavation was about 500 cubic yards of place measurement daily, all of which goes out through the west heading to the main crusher plant.

A very important advantage of this method of tunnel driving described herein, as previously mentioned, is that where bad ground is encountered no material delay is experienced. The bottom heading progresses on through the bad material, which is treated carefully and at leisure later on. This saves much time in the ultimate completing, and much money and risk in the construction. Some bad ground in break-ups where heavy internal stresses developed in the roof, require considerable timbering. This will be all concreted in with a reinforced single arch before the steam shovel reaches it, so that neither time nor money will have been lost.

In connection with the physical risk involved by this method it is interesting to note that within 15 months since the tunnel headings were started and with nearly a mile and a half of break-ups completed there has been only one fatal tunnel accident.

Bench Excavation.—The side benches, below the level of the jumbo timbers, are taken out, after the break-up excavation has been completed, by a steam shovel operated by compressed air. By this method the benches may be drilled and blasted well in advance and by a special loading device the usual delay in spotting cars is avoided, and no time will be lost by the shovel, making this excavation very cheap and rapid. At places where a steam shovel cannot be used because of timbering, special construction, or shield work, the benches will be handled by hand and a belt conveyor loading into the tunnel cars.

Shield Work.—At the city end where very soft heavy ground is encountered under most unfavorable conditions, a steel roof shield has been adopted. This avoids settlement of over-lying material, reduces the drainage of the surrounding ground, and eliminates the very heavy and expensive timberwork that would otherwise be necessary. This shield consists of a cutting edge, shaped to conform to the outline of the tunnel roof cross-section, which forms the front of a steel envelope extending over the platforms on which the men work and back far enough to lap over the last "ring" or section of tunnel lining erected. Steel poling boards, semi-attached to the shield will be used, especially in the boulder clay, thus producing a cutting edge that may be advanced in sections where desired.

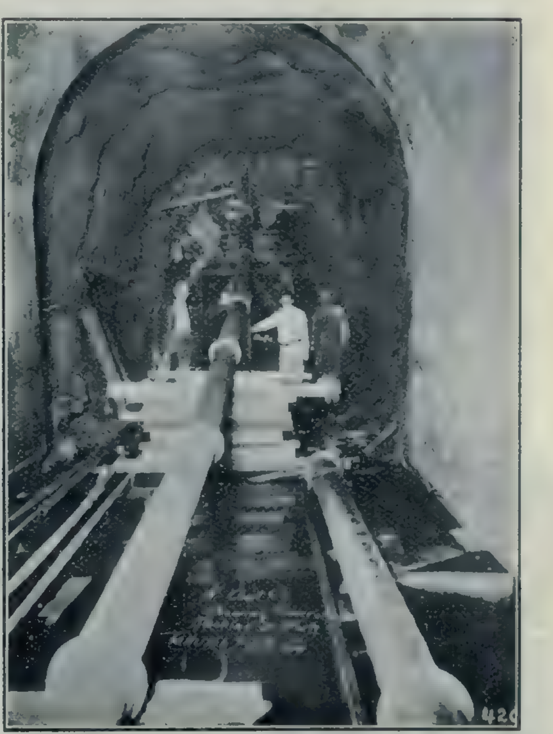


Figure 21.—Pneumatic concrete placing, in the Tallulah Falls tunnel where this process was used, which is to be tried on the Mount Royal Tunnel.

The shield is supported on steel columns forming the centre wall and on side walls which rest on the solid rock. It is forced ahead by hydraulic jacks, under a pressure of about 5,000 pounds per square inch.

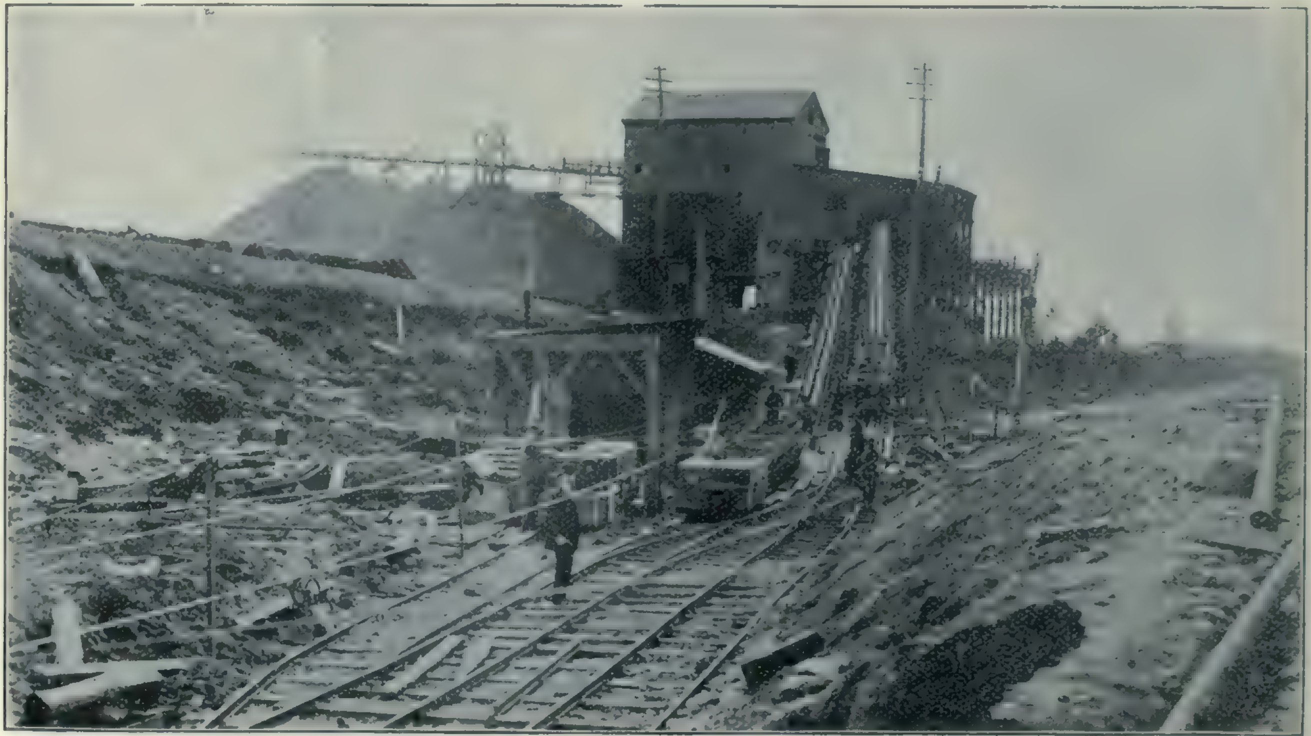


Figure 22.—Crusher plant and tipple at West Portal.

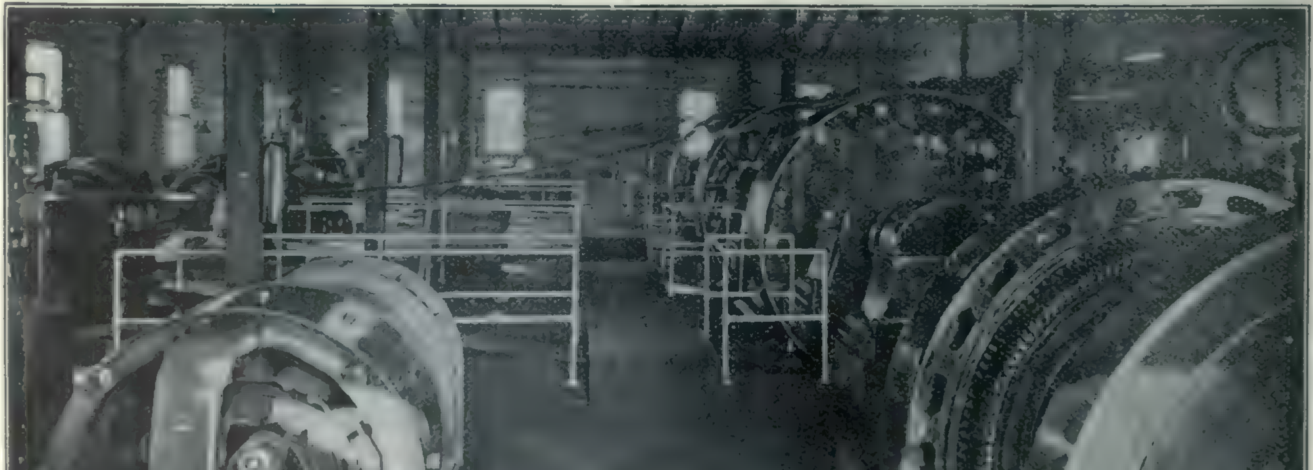


Figure 23.—Compressor house at West Portal.

These jacks push against the tunnel lining as it is erected.

The procedure is as follows:—after a shove, i.e., a move of the shield, 27 inches ahead, a ring of concrete blocks, 27 inches wide, along the axis of the tunnel, by 24 inches thick and about 5 feet long circumferentially, are set up in place by means of a hydraulic erector. When this tier of blocks is in place, the jacks are put in motion, jamming the new blocks hard against the last tier erected and forcing the shield slowly ahead, as fast as the ground is excavated in front of it. The excavated material, like that in the break-ups, is dropped directly into cars in the heading below. As soon as this shield has made a shove of 27 inches the process is repeated.

Where boulders are encountered the shield will be retarded and the steel poling boards advanced along the rest of the shield face for the 27 inch shove, when the boulder will have been removed in part or wholly. Where special rectangular sections are built, a steel structure will be erected and steel sheeting used over and around it. This steel sheeting will be advanced by jacks, the structural steel and enclosing concrete being placed under the sheeting as it advances. By this method the roof is never exposed; the men are never endangered by falling material, and if water is encountered the face can be protected by poling and breast boards with small pneumatic guns, or jacks, so that very little water or ground can escape.

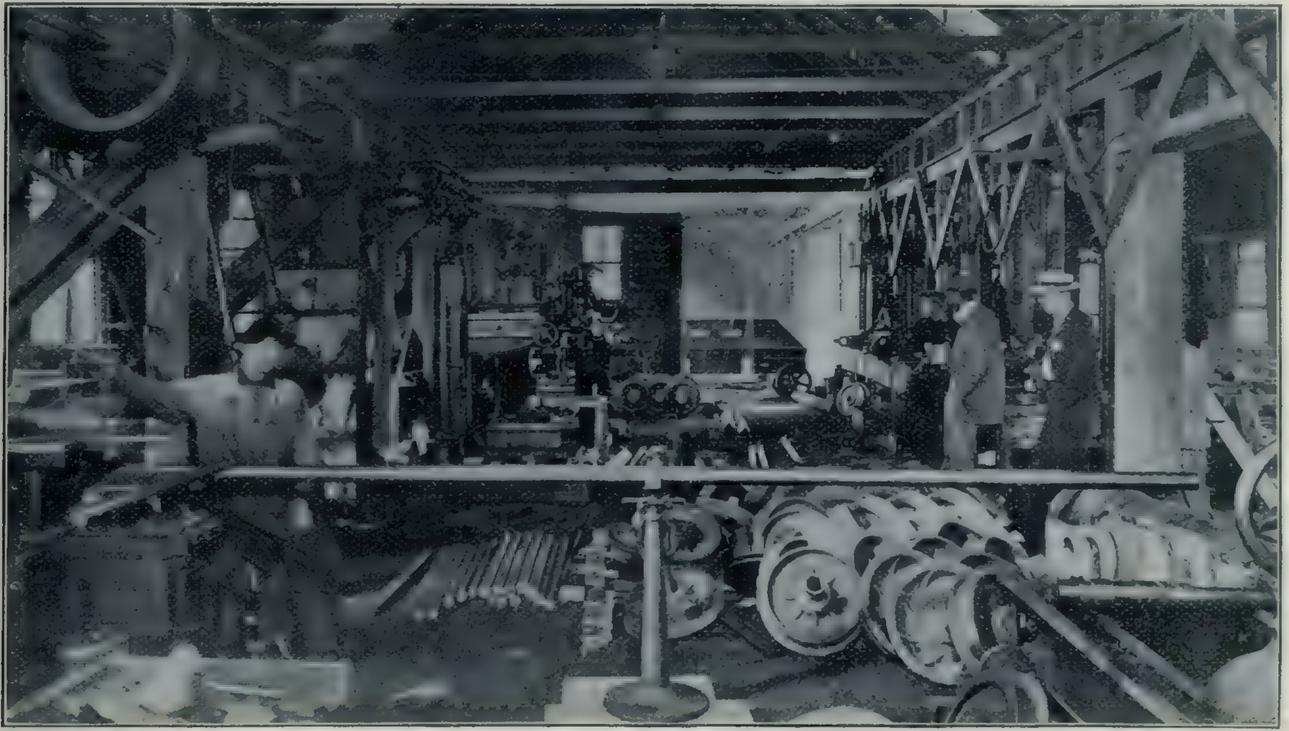


Figure 24.—Corner of machine shop at West Portal.

The blocks used (see Figure 19) were invented and patented by John F. O'Rourke of New York, who built the Hudson (North) River Tunnels of the Pennsylvania R. R. They are very massive and so designed that each block locks firmly into the two adjoining ones of the preceding ring, by oval shaped tenons. They are thus self-supporting and require no forms such as are usually necessary for concrete work. Since they are moulded many weeks in advance, before being brought into the tunnel, when they are erected under the shield they are sufficiently hard to withstand the thrusts of the jacks without injury. The blocks are also so designed that the extrados of the arch is continuous, but the joints in the intrados are about 1¼ inch wide. These joints are held to shape primarily by 3 part wedges or separators and later filled with mortar by means of a cement gun and grouting.

Pneumatic Concrete Lining.—At the back of the mountain and where the shield is not used it is proposed to try some experiments with mixing and placing concrete by means of compressed air. By this method ordinary forms are used and the concrete is conveyed from the pneumatic mixer (see Figures 20 and 21) to the forms through pipes by compressed air. If this method is successful it should very much reduce the labor required and prove to be both speedy and economical.

All forms used will be collapsible and movable so that they may be used repeatedly. Where convenient and economical steel forms will be used with travelling mechanisms to reduce the labor in handling and setting.

Construction Plant

Crusher Plant.—All the rock excavated in the tunnel is being crushed for road material and concrete stone. All that is not used by the company or railway is sold for local consumption about Montreal. The main crusher plant at the west portal (see Figure 22) consists of two No. 7 Kennedy gyratory crushers with Stevens-Adamson elevators, conveyors and screens. The capacity is about 1,600 cubic yards per day. The tunnel muck is hoisted in cars up an incline to tipples. After dumping, the empties are returned to the tunnel level, though a gravity switchback. The muck passes through the crushers and is elevated to a revolving screen which separates the stone into the various sizes and distributes it by chutes into bins. It can then be run directly into trucks or cars on tracks connected with both the C. P. R. and G. T. R. The overflow is carried on belt conveyors to various stock piles for the different sizes of stone. From these piles the stone is loaded by means of a locomotive crane and clam-shell bucket.

At the city end the tunnel rock is sold as it comes from the tunnel and crushed by an outside company.

Air Compressor Plant.—The compressed air used to operate drills, pumps and other pneumatic machinery is obtained from two plants (see Figure 23) one at each end; comprising an aggregate of 11,000 cubic feet of free air per min. compressed to 110 pounds per square inch. These plants consist of 8 cross compound compressors. Six are Blaisdell compressors, belt driven from Canadian General Electric motors, each compressor having a capacity of 1,100 cubic feet. Two are Sullivan compressors direct connected to Canadian General Electric motors, having a capacity of 2,200 cubic feet each. The power is purchased from the Montreal Light, Heat & Power Company at 2,300 volts, 60 cycles.

Shops.—Quite elaborate shops were equipped in order to make the job independent of local shops for repairs, and because it was cheaper to build the tunnel cars, of special design, on the job, than to buy them ready made. There was also special machinery such as the drill carriages to be built that would have been more complicated in an outside shop. It was found, too, that in the company's shop, three electric tunnel locomotives could be built for the price of two from the regular manufacturers and being built to special design enabled them to be used as 5 ton storage battery locomotives or 8 ton trolley locomotives, with very slight changes and at short notice. The shop equipment consists of 3 Ward drill sharpeners; one air operated steam hammer; a combined shear and punch for plate work; 3 lathes 60 in., 24 in. and 12 in. respectively; two 36 in, radial drills; two small power drill presses; two 24 in. power hack saws; one pipe and bolt machine; one shaper; two emery wheels; two large grind-stones; one oxy-acetylene apparatus; two band saws and two circular saws with the usual equipment of pneumatic and other small tools (see Figure 24).

Transportation Plant.—The transportation plant consists of one American saddle tank 30 ton "Dinkey" locomotive; two ten ton and one eight ton General Electric trolley locomotives for the tunnel; six 5 ton storage battery tunnel locomotives; two home-made electric tunnel locomotives, interchangeable from 5 ton storage batteries to 8 ton trolley locomotives; 215 tunnel cars, including all types; one Browning 45 ton 8-wheel locomotive crane; two Lidgerwood mine hoists with Eagle Iron Works automatic dumping shaft cages; the usual equipment of derricks and hoisting engines; one 7½ ton Commer auto truck; one 3 ton Alco auto truck; two Ford run-abouts; one 30 horse-power Cadillac touring car.

Drills.—The main drilling equipment consists of Sullivan percussive (reciprocating) drills fitted with a water attachment for hollow steel. Many details of these were designed especially for this work and are giving remarkably good results. The best light hammer drill found is the Hardy "Simplex." It is a 25 lb. self-rotating drill that has given most satisfactory results. A few numerous other makes of drills were tried or purchased principally for experimental purposes.

Miscellaneous Plant.—Cameron reciprocating pumps are used, and are, as always, satisfactory. Root blowers are used for ventilating. Berger surveying instruments are being used with most accurate and satisfactory results.

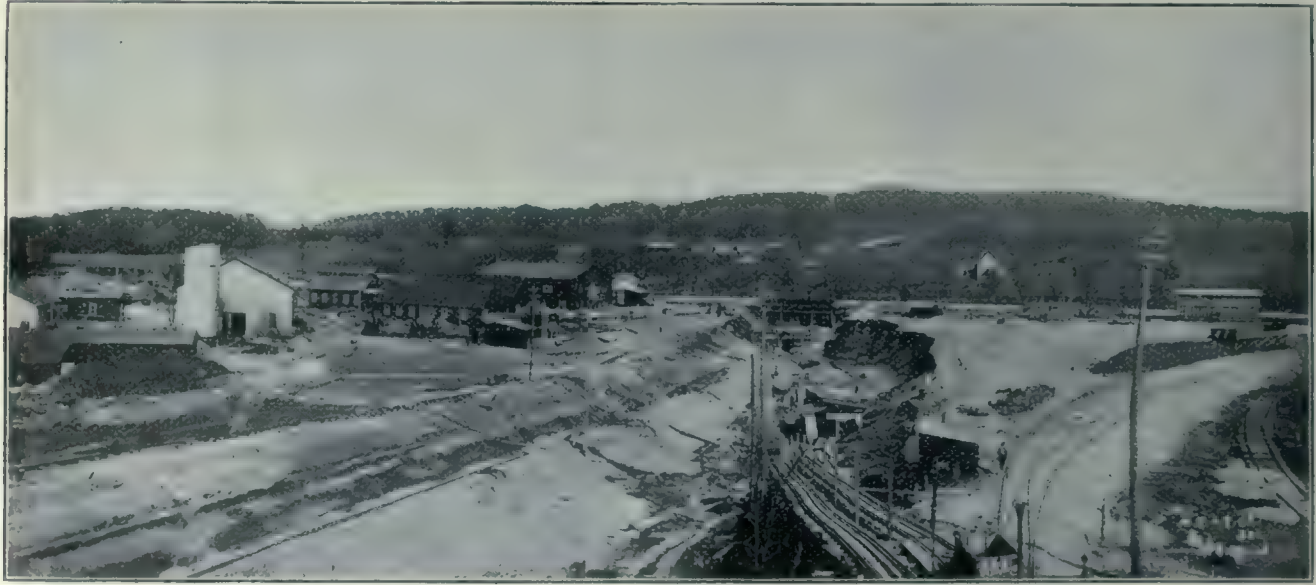


Figure 25.—General panorama at West Portal, showing plant and camps.

Synopsis

Mount Royal Tunnel.—Length, 3 1-10 miles; heading in station site, 1-3 mile; grade, 0.6 per cent. down towards the city; section, 23.5 feet high by 31 feet wide, standard excavation; type, twin tube; depth, 600 feet below summit; geology, Trenton limestone and Essexite with igneous dykes; method, bottom centre heading and break-ups; progress, best single heading 810 feet in 31 working days, averaging 420 feet per month in each heading; gross average 1,100 feet per month.

ESTIMATED QUANTITIES

Tunnel.—Excavation, 20,000 cubic yards of earth, 405,000 cubic yards of rock; concrete, 50,000 cubic yards; steel and iron, 4,400,000 lbs.; shafts, Maplewood, 240 feet deep, Dorchester, 55 feet deep; present pay-roll, 1,000 employees; present daily consumption of 60 per cent. dynamite, 2,000 lbs.; present daily rate of solid excavation, 900 cubic yards.

Terminal Site—Exclusive of Terminal Buildings.—Length, 1,200 feet; width, 350 feet; depth, 50 feet maximum; total tracks, 13; excavation, 540,000 cubic yards earth, 95,000 cubic yards rock; concrete, 100,000 cubic yards retaining walls, track, slabs and platforms; reinforcing steel, 3,500,000 lbs.; structural steel, 8,000,000 lbs.

Mount Royal Heights Station.—Length, 500 feet; depth, 35 feet maximum; excavation, 24,000 cubic yards earth, 7,000 cubic yards rock; concrete, 7,000 cubic yards.

ENGINEERING AND CONSTRUCTION ORGANIZATION

S. P. Brown, Managing Engineer for Mackenzie, Mann & Company, Limited, Chief Engineer of the Canadian Northern Montreal Tunnel and Terminal Company, Limited.

DEPARTMENT OF DESIGN

Electrical.—W. C. Lancaster, Electrical and Mechanical Engineer; R. H. Wheeler, Asst. Electrical Engineer; P. A. Fawell, Electrical Draftsman; J. F. Faber, Electrical Draftsman.

Structural.—H. D. Robinson, Engineer of Structural Design; C. M. Gray, Assistant Designer; W. E. Joyce, Assistant Designer; Ray Wick, Assistant Designer; W. P. Best, Chief Draughtsman; F. A. Guenther, Draughtsman; J. E. Stata, Draughtsman.

DEPARTMENT OF SURVEYS AND ALIGNMENT

Howell T. Fisher, Tunnel Engineer.

Eastern Division.—J. L. Busfield, Assistant Engineer; R. R. Stevenson, Instrument Man; W. H. Abbott, Level Man; two assistants.

Western Division.—R. S. Bassett, Assistant Engineer; A. F. Duguid, Instrument Man; C. F. Doore, Level Man; two assistants.

Inspectors.—G. C. Leclair, Chief Inspector; W. A. Gilmour, M. W. Maxwell, and J. J. McNulta; two assistants.

DEPARTMENT OF ACCOUNTS

C. C. La Bree, Managing Accountant; R. L. Munro, Cashier; H. L. Horne, Chief Storekeeper; A. E. Strugnell, Chief Time Keeper.

PURCHASING DEPARTMENT

F. B. McFarren, Purchasing Agent; J. P. McGuire, Asst. Purchasing Agent.

DEPARTMENT OF CONSTRUCTION

J. C. K. Stuart, First Assistant Engineer; Rufus Gent, Master Electrician and Mechanic; John B. Elwood, Efficiency Engineer.

Eastern Division.—Edward Duffy, General Superintendent; C. Phillips, Day Walking Boss; F. Braison, Night Walking Boss; A. Brown, Asst. Master Mechanic; C. Griffen, Chief Electrician; E. Bosslet, Boss Carpenter.

Western Division.—Richard Byers, General Superintendent; Wm. Irwin, Night Superintendent; E. R. Farrell, Day Walking Boss (Portal); Edward Farrell, Day Walking Boss (Shaft No. 3); T. Litterini, Night Walking Boss (Portal); J. Penders, Night Walking Boss (Shaft No. 3); W. R. Tiner, Asst. Master Mechanic; W. T. Leslie, Chief Electrician; R. Robinson, Yard Boss; O. Sinclair, Boss Carpenter.

DEPARTMENT OF BUILDINGS

C. Gordon Mitchell, Inspecting Architect; W. W. Kissock, Photographer.

MEDICAL DEPARTMENT

Mackenzie and Mackenzie, Limited, in charge. J. P. Mitchell, M.D., Visiting Doctor; J. Guy W. Johnson, M.D., Supervising Doctor, East; A. J. Charette, M.D., Supervising Doctor, West.

Paints and Their Applications

BEFORE a recent meeting of the Vancouver Branch of the British Columbia Society of Architects, Mr. H. H. Welch, local manager of the British America Paint Company, Vancouver, discussed paints and their applications in the course of an interesting paper, conveying many practical points in relation to the subject. Corroded white lead, defined basic carbonate of lead, was really a combination of hydrated lead oxide with lead carbonate in the proportions of one of the former to two of the latter, though these proportions were varied extremely. A theoretically correct composition of white lead was very dense and opaque and quite white (though not so white as oxide of zinc) and any excess of either chemical constituent impaired its color and quality. Describing the "old Dutch" or "stack" as being the oldest and perhaps the best process in the several methods of corroding lead, Mr. Welch told how metallic lead was melted, cast into perforated discs or buckles about 6 ins. in diameter, which were put into earthen pots containing about a pint of vinegar or diluted acetic acid. These were placed in rooms holding several layers of many hundred pots each, the latter being covered with boards and layers of spent tan bark placed between each layer of pots. The rooms or stacks were kept closed for about one hundred days during which the heat and carbonic acid generated by the fermentation set up combined to corrode the lead more or less completely into a flaky white substance. After this it was crushed, screened, floated, washed in water and dried, the result being the white lead of commerce which was afterwards ground in raw or refined linseed oil and sold for general painting purposes.

Other processes of manufacture dealt with included the cylinder or quick process in which the molten lead is blown into fine granules by steam; and the Dahli process which consists of slowly pouring the molten lead into cold water, thus reducing it to a thin fluffy condition. This was then placed in stationary tanks from which a stream of diluted acetic acid was continually flowing which eventually took it up and converted it into basic acetate of lead. A stream of carbonic acid was passed through this solution thereby precipitating the lead in the form of basic carbonate. Lead corroded by this process was finer and whiter and took up more oil in grinding than other leads but lacked the dense opacity of corroded lead. There were other processes of obtaining white lead but these were the methods generally used. Mr. Welch proceeded to examine the main characteristics of basic carbonate white lead, and regarding the boiling of oil said there were several methods, the prevailing one being the so-called "bung hole" boiling which was a pernicious practice, as no good lasting job could result.

The oxidation of paint was of the utmost importance, because the absorption of oxygen by the linseed oil entirely changed it from a fluid to the tough leathery coating so necessary for the purpose of preservation. In this process of oxidation the linseed oil gained in weight about 16 per cent. The life of a good paint varied, but should not be less than three years. The speaker went on to deal with the creosote stains for shingles, pointing out that while a good wood-preserver, creosote was a poor binder for the pigments used in making stain. It was very penetrating, with the result that the vehicle penetrated into the cedar and left the coloring matter on the surface with no binder to hold it on.

The Proposed Extension of Toronto's Waterworks System

IN a recent issue of the Contract Record brief reference was made to the report issued by Mr. R. C. Harris, Commissioner of Works of the City of Toronto, in the proposed extensions of Toronto's waterworks system. The publication of this report has given rise to a good deal of discussion regarding the merits of the alternative proposals, and also of the original solution of the problem as offered by the board of experts appointed by the city in 1911, in their report of May, 1912. We publish herewith a summarized report setting out the main points upon which the respective schemes differ, supplemented by the chief points raised in the criticism. As our readers will remember, the board of water commissioners consisted of Mr. J. G. Sing, of Toronto (chairman); Mr. Willis Chipman, of Toronto (secretary); Mr. Isham Randolph, of Chicago, and T. Aird Murray, of Toronto. The following synopsis will convey the principal features of the scheme recommended in the report by the board of experts, which provides for the installation at Scarborough Heights of an intake, tunnel, filtration plant and reservoir, with gravity feed mains to the city, the total estimates therefor amounting to $5,320,000.

A pumping plant five miles east of the present city limits; and at a point two mile to the south of this plant, in Lake Ontario, and at a depth of one hundred feet an intake crib of concrete and steel was to be sunk, having a diameter of 110 ft. at the base and a height of 115 ft., at an estimated cost of $500,000. The Commission recommended that the intake crib be connected with the shore pumping station by a two-mile tunnel 10 ft. in diameter, to be constructed in the shale of the Hudson river formation at a depth of 160 ft. below the lake surface at an estimated cost of $633,600.

The board of experts proposed to establish a pumping station adequately protected, at the foot of Scarborough Cliffs, the pumping machinery to comprise four electrically-operated pumps each of 15,000,000 Imp. gal. capacity for 24 hours, electric current to be transmitted to the new pumping house from the municipal hydro-electric sub-station to be erected at the south-east corner of Gerrard street and Carlaw avenue, a distance of about eight miles. It was recommended that in order to avoid the possibility of interruption to the service another independent source of electric power should be obtained, preferably from the River Trent. With these pumps it was proposed to elevate the water to a reservoir and filtration plant 355 and 370 ft. respectively, above the lake level. A 130,000,000 gallon reservoir at an estimated cost of $1,071,000, was also proposed, the supply to be allowed to gravitate through a steel conduit varying in diameter from 78 ins. at Scarborough to 66 ins. at the high-level pumping station on Cottingham street.

Extracts from Commissioner Harris's Report

The following is a summary of the report issued a couple of weeks ago by the Department of Works, City of Toronto. The report condemns the Scarborough scheme as recommended in the 1912 report of the Commission appointed by the city in 1911 to investigate the problem, and a proposal is made covering the installation of a plant at Victoria Park to filter and pump directly into the mains.

In the Commissioners' report it is proposed to build an intake crib off Victoria Park, 5,100 feet from shore. The crib will be approximately 110 feet in diameter, constructed of steel and concrete, and surmounted by a house, the main part of the crib rising 19½ ft. above the lake, the crib to contain the necessary ports for the admission of water. The inside of the crib will contain a vertical steel shaft, lined with cement or brick-work, running down to the proper depth below lake level, so as to connect with a tunnel 6,380 ft. long, running horizontally to the shore at Victoria Park. The internal diameter of the shaft would be 11 ft., that of the tunnel 9 ft., the latter to have its invert 105 ft. below mean lake level. At the shore there will be a vertical shaft 10 ft. in diameter rising above the normal lake level at this point. From the vertical shore shaft there will be two horizontal, 7-ft. tunnels, one on each side and parallel with the shore. One of these tunnels will supply the suction side of the pumps in the station to be erected, the other will act as a reserve to be used in case the size of the station is increased later.

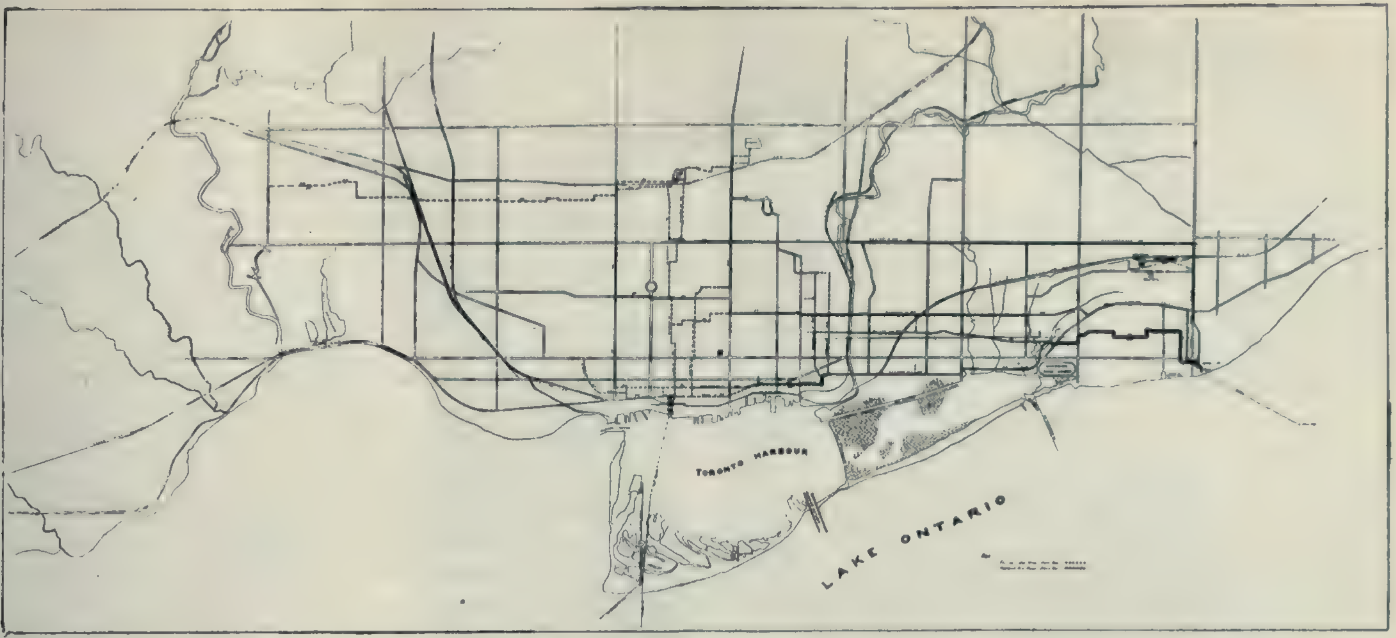
The pumping station, which will have a capacity of 60,000,000 Imp. gals. for the 24 hours, will be located in Victoria Park, which with the piece of land to the east, is of sufficient size to contain a station and filtration plant of 120,000,000 Imp. gal. capacity for 24 hours, should such a capacity ever be required.

Since the water will have to be filtered the station must be divided into two parts, viz., low-life and high-lift, the former taking the water from the tunnel shaft and delivering directly to the filters, while the latter will deliver the filtered water direct to the city mains. Each part will have a capacity of 60,000,000 Imp. gal. The low-lift pumps will work against a head of approximately 75 ft., while the approximate head on three of the high-life pumps will be 220 ft., or 95 lbs. per sq. in., and that of the fourth pump about 315 ft., or 137 lbs. per sq. in.

The mechanical type of filter is recommended, and in connection with this it is proposed to instal a reservoir with a capacity of two-and-a-half-million Imp. gal., and to provide space for a settling basin should the make of filter require it. From the station four 36-in. pipes will deliver water to four new 42-in. mains which join the present distribution system.

Briefly the plan contemplates: 1. A system which will supply an additional quantity of water equal to that now being used during maximum draft, thus practically duplicating the present plant. 2. A system which will operate in exact harmony with the existing plant, thus enabling both to work in conjunction. 3. An arrangement which can be doubled in capacity without doing unnecessary work. 4. A supply which is unfailing, in so far as human agency can make it. It will not be deleteriously affected by storms, ice, shifting sand, etc. 5. A supply of water, which is as pure as it is possible to obtain in the vicinity of Toronto, and which after treatment will be safe and satisfactory. 6. An improved service throughout the entire city. 7. An attractive park on the waterfront.

In the opinion of the Department of Works an ad-



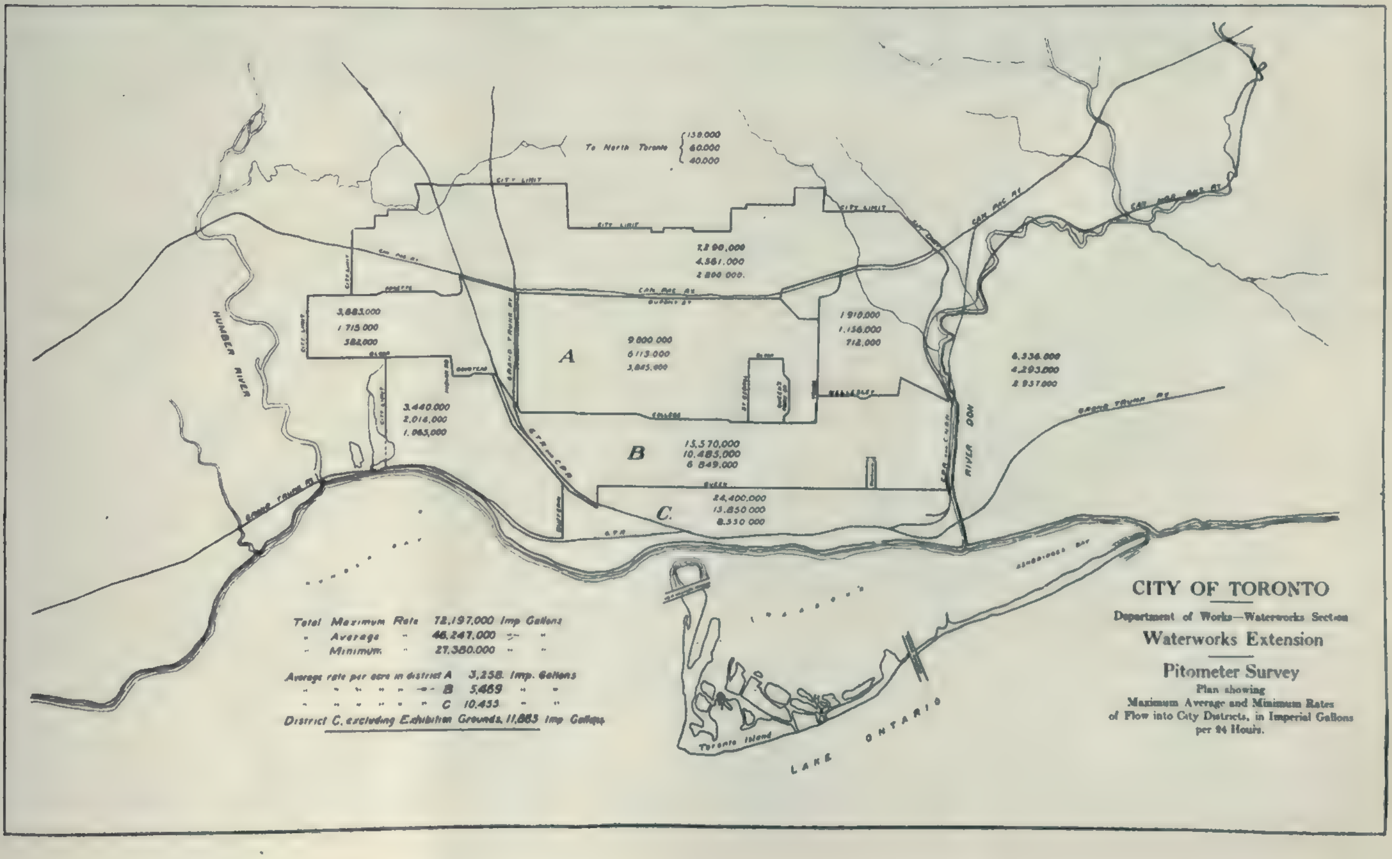
General plan of the City of Toronto, showing existing large mains and proposed new mains.

ditional reservoir for the city is not essential, but it is desirable that there should be some water storage to provide for fluctuations in demand from time to time. This storage has already been adequately provided for in the Rose Hill reservoir which has ample capacity for all the present and proposed pumping equipment. The present Rose Hill reservoir has a capacity of 39¼ million Imp. gal. or about 20 hours supply at the present average daily pumpage of approximately fifty million Imp. gal. and is quite sufficient to compensate the ordinary fluctuations of discharge.

From the pump house there will be four 36-in. pipes, with Venturi meters, running a short distance from the station, after which they will be enlarged for distribution purposes, and will feed four 42-in. mains, all of these pipes being cross-connected and controlled by valves in such a way as to make a perfectly flexible arrangement.

The discharge pressure on the pumps at the high-level station supplying the middle district is 65 lbs. per sq. in., and hence, after making allowance for friction and difference of level, the pressure at the Victoria Park station on the pump supplying the 42-in. main will be approximately 137 lbs. per sq. in. While this pressure is higher than usual, yet the pipe rises rapidly after leaving the station, and only about 2,000 ft. of it would be subjected to a pressure of over 100 lbs.

It is held that this distribution plan will give ample



accommodation for the water for the new station to reach all points of the city, and will enable the new station to work in perfect harmony with the present plant. In addition to the supply feature, provision is made for 32 miles of large distributing mains, at a cost of approximately $2,393,000. The following are the main items in the estimated cost of the project as recommended:

Lake crib—complete and placed	$400,000
Lake shift, tunnel and short shaft	800,000
Site and buildings	500,000
Pumping equipment	380,000
Tracks and overhead equipment from York to pumping station	35,000
Twenty-six miles of distribution mains ...	2,040,000
Filtration plant	600,000
Levelling, grading, etc.	5,000
Six miles of distributing mains—high level pumping station to West Toronto, for part of which contracts have been awarded ...	353,000
Additions to high-level pumping station, and provision of steam reserve sufficient for ultimate output of this station, for part of which contracts have been awarded	250,000

which with a few minor items make a total estimated cost of $6,033,700.

Defence of the Experts' Scheme

Mr. Willis Chipman, Secretary of the board of experts responsible for the preparation of the Scarborough report, commenting on Commissioner Harris's remarks said:—"There is nothing in the Scarborough scheme suggested by the board of experts for the extension of the Toronto waterworks system that cannot be solved by the ordinary principles of hydraulics." While admitting that the Victoria Park scheme recommended by the Commissioner as a substitute for that advocated by the experts contains some good features, Mr. Chipman pointed out that its greatest weakness was that it was proposed to take water from the lake at a point where the water was polluted by sewage only 2½ miles from the main sewer outfall at Morley Ave., whereas in the Scarborough scheme it was proposed to obtain water from a point seven miles from the sewer outfall. He admitted that if the citizens were prepared to drink "doctored" water there was no valid reason why they should not take the water from the Bay, now that sewage was not dumped therein. Such water could undoubtedly be purified by chlorination, but it was likely to have an unpleasant taste. He had always refused and would continue to refuse to be a party to taking any kind of water for domestic purposes simply because it might be purified by a process. If the Commissioner's scheme were adopted it necessarily followed that water obtained from that source would be, roughly, twice as impure as that obtained at the present intake, as an evidence of pollution by sewage was found to be extensive within a radius of over five miles from the present intake pipe.

Mr. Isham Randolph, also of the board of experts, said he had noted that Mr. Harris seemed deeply concerned in discrediting the work of the experts. Mr. Randolph took exception to many of the deductions drawn by Commissioner Harris. It was true that some of the recommendations made by the experts did not follow proved practice, but if in the development of the world's mechanical and structural creation proved practice only had been followed, what would have been the state of civilization to-day? The Commissioner's objection to the proposed tunnel under the lake he considered out of place, as this was quite feasible and practicable. In Chicago a tunnel had been constructed 163 ft. below water surface, while the water tunnel under the Hudson river at Catskill was 1,100 ft. below water surface.

Another gentleman in close touch with the work of the experts expressed the opinion that in voting for the money by-law last year for waterworks extensions the ratepayers thought they were voting for the extension of the Scarborough scheme recommended by the experts. He thought in the event of the city council adopting Commissioner Harris's scheme it would be within the province of any taxpayer to apply to the courts for an injunction to prevent the execution of the work until the people were given another opportunity to vote the money.

Progress at St. John, N.B., Greatest in a Quarter of a Century

Correspondence of the Contract Record

WITH building permits to the value of $2,380,000 last year the city of St. John made greater progress in construction work than in any year for a quarter of a century. The Metcalf Construction Company completed a million-bushel grain elevator for the Canadian Pacific Railway Company and has since practically completed the erection of grain conveyors from the two elevators to two additional steamship berths. The splendid new armory, which had been begun in the previous year, was completed and is now occupied by the Militia. The new Imperial Theatre, the finest east of Montreal, fronting on King Square, was completed. The Merchants' Bank of Canada purchased a building and added another storey, completely remodelling the whole structure, and Bank of British North America has now nearing completion at the corner of Dock street and Market Square a very handsome bank building of concrete and steel. Speaking of banks it may be noted also that the Bank of Montreal remodelled its premises at a cost of $30,000, while the Royal Bank has now nearing completion a branch building in the north end, constructed of concrete. The Ames-Holden McCready Company, Limited, erected a seven-storey warehouse on Water street. The Federal Government is completing a new observatory on Douglas Avenue.

Of large structures not yet completed are the sugar refinery, one of whose largest buildings is approaching completion, and the new post office, of which the steel frame is now being erected. Men were engaged throughout the summer and fall and well into the winter in getting the foundation for the post office, as it had to be blasted out of the rock to a depth of nearly twelve feet below the sidewalk, and the work was especially slow and tedious. The Rhodes, Curry Company, Limited, are erecting this building and the work on the sugar refinery has been carried on by the Foundation Company and the Dominion Bridge Company. The task of securing foundations both for the sugar refinery and the C. P. R. grain elevator was a very heavy one, as in both cases it was necessary to go deep to get a solid foundation, and in both cases the harbor water interferred to some extent with the prosecution of the work.

One of the heaviest construction works of the season was the placing in position of the immense timber cribs to make the foundation for three new wharves, of which the surface is to be of concrete. Owing to an average tidal variation of about twenty feet, and the fact that there must be thirty feet or more of water at extreme low tide, it is necessary to have timber cribs of great depth. During a tremendous storm in the early winter two of these great cribs were detached and went adrift into the harbor. They were captured and grounded, but are still there, and it may be necessary to take them in pieces and rebuild the whole structure. The federal government has cancelled the contract of Messrs. Connolly & Charleson, and will immediately make other provision for the construction of these cribs.

Fairly good progress was made last year in constructing the concrete foundations for the new street railway and traffic bridge, to connect east and west St. John, and it is stated that the Dominion Bridge Company will begin work on the superstructure early next summer. It is said that this will be the longest spandril arch bridge in the world, and the work of construction will be attended with the greatest difficulty. At Courtenay Bay, in the eastern harbor of St. John, Messrs. Norton Griffiths & Company are making progress with the immense breakwater, mut have had great difficulty and many mishaps to their plant in connection with the very large dredging contract, to make a channel into Courtenay Bay and a basin inside the breakwater. In fact they have only done a little dredging at the mouth of the channel, and a much more extensive plant must be put in commission this year.

New Armoury at St. John, N. B.

The St. John Railway Company has extended its line in two directions for a short distance out of town and will this year make further extensions; and it is announced that as a result of this several building companies will take up the work of constructing groups of houses, which are greatly needed to relieve the congestion caused by a growing population. The city will probably have as great activity in construction work this year as last. The city council will continue its policy of making permanent streets, and will have a bill before the legislature next month asking authority to make the abuttors along the streets pay half the cost of the permanent work.

Outside of the city of St. John, the Foundation Company now have men at work at several points on the St. John river seeking to find a foundation for the great bridge over which the St. John Valley Railway will cross the St. John river. Another immense bridge must be constructed over the Kennebeccasis river, and it is expected that the provincial government will lay before the legislature a proposition concerning this work, which will cost considerably in excess of a million dollars. At Newcastle, the Foundation Company has been at work for the past year on the foundation and piers of a bridge across the Miramichi river, which will have a span of about 1,250 feet and for which it is necessary, because of the depth of water and the nature of the bottom, to construct piers some sixty feet below the level of the water, and then place them upon piles driven into the clay below. The general manager of the company says that this bridge is the most considerable undertaking in bridge construction that has yet been started in the eastern provinces, but the sub-structure will be completed in its essentials in March next.

Reviewing the building situation in New Brunswick generally, it is noted that there was general activity in all the towns last year, and that the prospects for this year are very good.

Hollow tile for partitions is made in two grades known as porous and semi-porous, the result of mixing in the clay a proportion of sawdust which burns out, 20 per cent. of sawdust being used in the semi-porous, and 25 to 35 per cent. in the porous. This leaves the finished product in such a condition that it can be cut with a saw and nails can be driven into it, says Henry G. Tyrrell in Engineering Magazine. The semi-porous is used for partitions with about 40 per cent. of full porous ones to hold the nails where trim is needed. Solid or dense tile is suitable for floors but not for partitions, excepting perhaps in outside exposed positions, and wood nailing strips must then be inserted if nailing is needed. The blocks are made either 12 inches square or in either form, 12 inches long and 4 to 8 inches deep, but the large square ones can be laid much faster than the smaller ones and at a less labor cost.

The new building in New York city for the Consolidated Gas Company will have its facades illuminated at night by concealed lights in such a way as to give a most brilliant effect. Another new feature, and an interior detail that we understand has never been tried before, will be the lighting of the large hall, which is reached from the main entrance in Fifteenth street. Here there is a series of Pavanazda marble arches, in each of which are several panels of the same marble a quarter of an inch thick. Behind these panels there will be concealed lights which will shine through the marble panel work, producing a most remarkable lighting effect. The new building is fireproof, and in this connection what is said to be an absolutely new system has been worked out and approved for the carrying of wires, telephone, high tension, electric light, gas and other pipes through combination boxes built in the floors.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

It is officially stated that the Union station at Quebec, and the improvements and terminal facilities at St. Malo, will be commenced on May 1.

The City of Maisonneuve, Montreal, have purchased a block of land lying between Sherbrooke Hill and Rosemount Boulevard for $1,500,000 to complete the 400 acres available for a park to serve the east end. The entire cost so far is $2,500,000.

An opportunity for starting a brick-making plant would seem to be available in St. John, N.B., where a bed of clay of large area and from 23 to 26 feet thick, with a clay or sand formation underneath, has been located near Fairville, N.B. The land is owned by the city.

Mr. H. A. McLean, town engineer of Sarnia, is engaged on the new $250,000 waterworks system for that district. Several other important works have been carried through under Mr. McLean's guidance, notably the new electric lighting plant which was recently installed at Forest, for which he is also consulting engineer.

The Dominion Steel plant, Sydney, N.S., which had been closed two weeks for repairs, re-opened on January 26, and the general manager has announced that sufficient orders have been received to keep the works going at full output until well into the summer. The firm have an order on hand for the Australian Government.

The Controllers of the city of Montreal have been authorized to issue a loan for two million dollars for the purpose of establishing and maintaining an electric plant, in connection with the enlargement of the aqueduct. Part of the power generated will be used for pumping water, and part for a municipal lighting plant.

On the advice of the law department, the Controllers of Montreal will hold an administrative investigation into the causes of the recent break in the conduit. The Controllers will await the granting, by the Quebec Legislature, of powers to enforce the attendance of witnesses, and examination under oath, before opening the inquiry.

Mr. Macallum, city engineer of Hamilton, has announced the preparation of plans which might do away with the necessity of the proposed new sewage-disposal plant at the extreme east end of the city. His new plan involves an enlargement of the existing plant at Trolley street with a new pumping station at the foot of Kenilworth street.

The appointment of a Parks Purchasing Committee for Toronto was again advocated in the annual report of the executive committee of the Toronto Civic Guild, read before the annual meeting recently. Among the suggestions was one that a board of experts be appointed to study the question of assessing the cost of such improvements as new streets, street widening, etc.

The Hamilton board of control have passed on the new building by-law to the city council. The principal objection to the by-law as framed was that all but first-class fireproof buildings were prohibited erection in the central business district, which was considered a hardship and likely to curtail building operations. The controllers have amended it so as to provide for the erection of second-class buildings in the districts specified.

The Exchequer Court, with Hon. Walter Cassels presiding, is conducting proceedings in Toronto for the expropriation of Adelaide street property to be used as a site for the new general post-office. Although nothing definite has yet been announced it is understood that the new building will take in the entire block bounded by Victoria, Lombard, Church and Adelaide streets.

On March 3 the City of Montreal will call for tenders for the construction of the fourth and last section of the civic filtration plant at Point St. Charles, the plans of which have been drawn by Messrs. Hering & Fuller, of New York. The cost is estimated at $150,000, the work including the pumping station, the wash-water tower, the superstructure of the filter building, and the gate-houses. When completed, the plant will cost $1,350,000.

Owing to depression in the building trade throughout the west the Canada Cement Company have decided to close down their plants at Marlbank and Lakefield, Ont., and Calgary, Alta. Two other operating plants of the same company, one at Winnipeg and one at Exshaw, will continue to operate. The circular sent out by the general sales manager at Montreal merely states that the plants will remain closed until the end of the present year unless demand warrants earlier re-opening.

Norton Griffiths & Company, of London, Montreal, and St. John, N.B., have, in conjunction with W. H. Brown & Company, New York, made an offer to the Mayor of Chicago to organize a company with power to issue $150,000,000 worth of 5 per cent. bonds for the purpose of building and operating a system of subways. The first unit would consist of thirty miles. After operating, maintenance, interest and sinking fund, and a 3 per cent. dividend, 55 per cent. of the surplus is to go to the city and 45 per cent. to the operating company.

Next June it is proposed to hold a national town-planning congress in Toronto with the object of considering measures for the carrying out of a uniform system of town-planning. At the fifth annual meeting of the Commission of Conservation the report of the advisory committee, which for some time past has been investigating with a view to formulating a scheme applicable to all provinces, was presented and the draft bill submitted, the latter containing a proposal to create local town-planning boards in each municipality to co-operate with the central authority.

The Executive of the Great Waterways Union of Canada, at a meeting held in Berlin, Ont., on January 22, passed a resolution tendering the Dominion Government its appreciation for the prompt and business-like action it has taken in the construction of the new Welland Canal as a link in the waterway from the ocean to the Great Lakes. A further resolution was passed urging upon the government that in the event of the appointment of a Royal Commission to investigate the commercial feasibility of the Georgian Bay canal, western Ontario and the prairie provinces, being more vitally interested than any other parts of Canada, be granted full representation, and that such investigation be made to cover the entire route from the Georgian Bay to Montreal.

By striking out the paving clause the Private Bills Committee of the Quebec Legislative Council have restored to its original position the Montreal bill as regards the special tax for street paving. The clause as adopted leaves the question of cost to the decision of the majority of the Montreal City Council. If the majority is against the levying of the special paving tax the city will have to pay out of the loan account. By the old paving law the cost was provided by special tax on property owners. Now the clause leaves this optional for the Board of Control to get what terms they can with the majority of the Council.

Contract procedure is criticized in the fifth section of the Civic Survey report on the Toronto Department of Works. The report in this respect is based upon an analysis of about two hundred contracts and in view of the facts disclosed the committee recommend among other things that more care be given to the preparation of the engineer's estimate of quantities and total cost, that the right to extend the time limits on contracts be vested solely in the board of control, and that the practice of undertaking contracts before their final execution, and beginning the work before the issuance of the formal order, be discontinued.

The Methodist Book & Publishing Company are immediately commencing work upon excavations for the new buildings on John, Queen and Richmond streets, Toronto, the cost of which, when completed, will total close on $1,000,000. With a Gothic style of architecture the base course to a height of eight feet will be of granite, and thence to the roof white glazed terra cotta will be used. The floors will be of reinforced concrete and hollow tile construction, and all frames used will be of bronze. It will be a five-storey structure but provision will be made for the addition of another five if required. The contract for the structural work has been awarded to the John H. Parker Company, Limited, New York and Toronto, the price being about $600,000.

Quebec Architects' Annual Meeting

The members of the Architects' Association of the Province of Quebec held their annual meeting recently in the city of Quebec. The report submitted stated that 21 new members had been admitted. The Quebec section reported a satisfactory year, and the hope was expressed that the city may be induced to accept the building by-laws recommended by the association. It was suggested that the Quebec legislature should amend the statutes in such a way that qualified architects might be put on the same footing as other professions and that they might be admitted before the courts of justice to prove professional services rendered by oath instead of in writing. The association's income was $2,903 and expenditure $2,685, the total balance being $3,643. During the discussion the question of the present method of taking off quantities was mentioned. This will probably be considered during the current year. At present each contractor tendering on a job takes off his own quantities, which involves a considerable cost. In Great Britain the work is done by quantity surveyors, and it is contended that this is a cheaper and more satisfactory system. The following officers were elected: president, Mr. W. S. Maxwell, Montreal; vice-president, Mr. Joseph Perrault, Montreal; second vice-president, Mr. Staveley, Quebec; secretary, Mr. J. Emile Vanier, Montreal; committee: Mr. D. M. MacVicar, Mr. Frank Peden, Mr. D. MacFarlane, Mr. E. Payette, and Mr. G. A. Monette. The delegates elected to the Royal Architectural Institute were: Mr. John Archibald, Mr. H. Marchand, Mr. Alcide Chausse, Mr. G. A. Monette and Mr. Edward Maxwell.

WESTERN CANADA

Edmonton hospital board require $62,000 to enable them to complete the new south wing of the building, this amount not having been provided for in the money by-law passed for the purpose.

A movement is on foot for the Board of Trade, the City Council and the Saskatchewan Industrial League to co-operate to assist industries locating in Regina, and to provide capital to help them extend their business.

A new detention shed of steel construction, with brick walls and concrete floors, is to be erected at Vancouver for the Dominion Immigration Department. The contract has been awarded to Snider Brothers at $277,449.

If the suggestions of the Regina Chief of Police are carried out, several new sub-police stations will be erected in Regina during 1914; an up-to-date signal system will be installed, and numerous other improvements made. A new police station to cost $180,000 will also be erected.

Much interest is manifested in Regina in the natural gas proposition which has been practically accepted by the city council. According to the terms of this agreement, the city will secure natural gas at twenty cents per cubic foot. With natural gas at this price, it is claimed that power rates for milling enterprises, etc., would be reduced to a minimum. The gas will be secured within one hundred miles of Regina, and piped to the city.

Manitoba's scheme to expend two and a half million dollars on road improvement has been brought before the legislature by Hon. Dr. Montague, Minister of Public Works. The government will provide 33 1/3 per cent. of the cost of ordinary roads and wooden bridges and 50 per cent. of the cost of gravel roads and permanent bridges. The money is to be spent under the supervision of a commission of three members to be appointed later.

The Assiniboia council, it is reported, have rescinded a contract awarded on December 3 to the Bitulithic Paving Company for the paving of seven miles of road from the Assiniboia city hall. It appears this company's tender was $29,000 higher than that of the National Paving and Construction Company. The contract will be re-let and a deputation is to wait on the provincial government regarding the granting of sectional aid for the construction of the road.

One of the largest dyking schemes ever undertaken in western Canada has been commenced by the Sumas Dyking Commission. The project involves 30,000 acres of land in the Fraser Valley, B.C., and the estimated cost is set down at nearly a million and a half dollars. The contract has been given to the L. M. Rice contracting firm of Seattle, Wash., and it is anticipated that the scheme, when completed, will open up one of the finest agricultural territories on the mainland of the Vancouver province.

On May 18-23 the first Canadian and International Road Congress will be held in Montreal. It will be attended by delegates from all parts of the Dominion. Several papers will be read, including one by Mr. W. A. McLean, provincial engineer of Ontario.

Mr. Paul D. Sargent, Chief Engineer, State Highway Commission, Augusta, Me., recently delivered an illustrated lecture on "Gravel and Its Use in Highway Construction" before the Graduate Students in Highway Engineering at Columbia University.

Mr. W. A. Mahoney, architect, Guelph, has opened an office in the Bank of Toronto Building, Berlin, Ont.

Canadian Railroad Development

The new C. N. R. branch from Prince Albert to Battleford, Sask., was officially opened on January 19.

It is understood that the Canadian Northern Railway Company has secured control of the Quebec and Saugenay Railway and that the former will erect extensive tunnels at Quebec, alongside the proposed terminals of the Canadian Pacific Railway.

Mr. F. P. Guteluis, general manager of the Intercolonial Railway, anticipates that during the next three years the entire 185 miles of the line between Halifax and Moncton will be double-tracked at an estimated cost of five millions. It is expected that fifty miles of the road will be done this year.

It is announced that an organization meeting has been called for February 14 of the Terminals Company that is to build the new Union Station at Toronto. Mr. Kelley, vice-president of the Grand Trunk Railway, assured the Dominion Railway Commissioners that plans for the station and the viaduct would be ready shortly.

An indication of the development going on amongst the various railway companies is afforded in the fact that during 1913 the railways have had under consideration 6,000 miles of new line. The Canadian Pacific has at present over 1,000 miles in hand, the Canadian Northern nearly 2,000 and the Grand Trunk Pacific about 1,000. The active work has been for the most part in three of the western provinces, and the following is the mileage possessed by the principal companies in these parts of the Dominion,—C. P. R., 1,675 in Manitoba; 2,633 in Saskatchewan; 1,597 in Alberta. C. N. R., 1,863, 2,021 and 795 respectively, and Grand Trunk Pacific, 314, 1,025 and 681 respectively. Altogether there are about 19,000 miles of railway in the Dominion and an estimate places the probable mileage next year at 35,000.

Personal Mention

Mr. Charles Hamilton Mitchell, C.E., has been elected president of the Toronto Civic Guild.

Mr. John Bingham, a well-known and highly respected Toronto contractor, died on January 22, in his 64th year.

The late Mr. Geo. C. Watson, who was a well-known Toronto builder and contractor, left estate valued at $36,055.

Messrs. James Cowin and E. F. Fee have formed a partnership in Winnipeg and intend specializing in reinforcing steel.

Mr. L. H. Bennett has received an appointment as school architect with the Regina public school board, at a salary of $2,500 a year.

Mr. J. Lanning, B.A.Sc., has been appointed a superintendent in the smelter works of the Mond Nickel Company, at Coniston, Ont.

Mr. J. T. Whitlam, chief building inspector of Toronto, has been seriously indisposed for some days, but his condition is now substantially improved.

The late Mr. Andrew D. Harris, president of the Ontario Sewer Pipe Company, Mimico, Ont., who died December 12, left estate valued at $257,426.

Mr. Geo. Spencer, of the Winnipeg staff of the Railway Commission, has been transferred to Ottawa to succeed the late Mr. A. J. Nixon as chief operating officer of the board.

Mr. R. MacKay Fripp gave an interesting discourse on "National Character as Expressed by the Architecture of the Home," under the auspices of the Housing Association in Vancouver on January 18.

Mr. Frank A. McInnes, formerly of Fredericton, N.B., and now chief engineer of the sewage and water division of the Public Works Department of Boston, has been elected president of the New England Water Works' Association, succeeding Mr. J. Waldo Smith, chief engineer of the Board of Water Supply, New York. Mr. McInnes is a graduate of McGill University.

Mr. G. Janin, chief engineer of the city of Montreal, has been granted a long leave of absence owing to illness. He has recovered from an attack of congestion of the lungs, but suffers from heart trouble.

Mr. Stanley M. Oborn, Toronto, and Mr. B. E. T. Ellis, who formed a partnership recently as consulting and civil engineers, will have two offices, one in Toronto in charge of Mr. Oborn, and one at Hamilton with Mr. Ellis in charge.

Mr. T. Rowland has been appointed hydrographic engineer for the Nicola District of British Columbia. He will reside at Nicola immediately and proceed to complete surveys of the district with a view to the development of irrigation.

Mr. G. R. B. Elliott, of Vancouver, was awarded the S. H. Hedges cash prize for his essay on the "Fraser River Delta," at the twelfth annual meeting of the Pacific North-West Society of Civil Engineers held in Seattle, U.S.A. Mr. Elliott has the distinction of being the first Canadian to secure the award.

Toronto Firm's Activities in Woodstock

Mr. J. L. Mitchell, manager of the Mitchell Crusher Manufacturing Company, Toronto, who for the last two years has been manufacturing his Mitchell improved crushers, screens, elevators and dump cars, in Toronto, as well as in New Hamburg, has succeeded in consolidating his Company with the Woodstock Wind Motor Company, of Woodstock, Ont. Mr. Mitchell obtained from the City of Woodstock a $20,000 loan for the purpose of installing new machinery in the present Wind Motor plant and also for erecting an addition to the building to accommodate a full line of concrete and road-building machinery, including concrete mixers, tile and concrete block machines, which will give to Woodstock one of the largest plants of its kind in the Dominion. Mr. Thomas Watson will be the general manager of the new company, which will be known as The Concrete Machinery Manufacturing Company, Limited. Having had several years' experience as a manufacturer of concrete machinery, Mr. Watson is entitled to credit for his efforts in bringing this important industry to the city of Woodstock, where it is hoped that his efforts will be attended with much success. Associated with him in the starting of the new company will be Mr. Mitchell who expects to go to England in the near future where, we understand, he has made arrangements to build the Mitchell improved crusher. The entire output is at present taken and disposed of as fast as completed, by Messrs. Wettlaufer Brothers, of Toronto. That the market is not by any means confined to Canada is proved in the fact that several shipments have been made from time to time to various parts of the British Empire (including Australia and South Africa) and also to Central and South America.

Morris Overhead Runways

Some very interesting recent installations of Morris overhead runways are dealt with in Bulletin A-12 which we have just received from the Herbert Morris Crane and Hoist Company, Limited, Empress Works, Peter Street, Toronto. Reproductions of some excellent photographs of these runways bear testimony to the flexibility and handiness of the system employed. The Morris runway is shown in the warehouse, paper mill and foundry, and the modification of the equipment to suit varying conditions is very interesting.

ESTABLISHED 1886

Contract Record
and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **February 11, 1914** **No. 6**

Principal Contents

Page
A Timely Enjoinder ... 159
The Example of Duluth ... 159
Pollution of Water Supplies ... 160
Problems and Methods of the Building Contractor ... 161
Letters to the Editor ... 162
Instructions to Building Inspectors ... 163
Proposed Second Narrows Bridge at Vancouver ... 164
Suspension Bridge Over the Kootenay River ... 166
Avoidable Defects in Concrete Paving ... 167
Permanency in Modern Road Building ... 168
Suggestions for the Utilization of Granite Block Pavements ... 169
Method of Making Repairs to Montreal Conduit ... 171
Economic Conduit Location ... 173
Waterproofing and Paint for Cement ... 175
History of the Montreal Waterworks with an Outline of Present Improvements ... 176
Montreal Builders' Exchange. Annual Meeting ... 185
Engineers' Club of Toronto. Annual Meeting ... 185
Constructional and Industrial ... 187-190

A Timely Enjoinder

FROM a perusal of the advertisements for tenders published in recent issues of this journal and by a comparison of such advertisements with those published a few years ago, one can discern an increasing tendency on the part of local authorities and public works officials to secure their bids well in advance of the active constructional season. Time was when it was the rule rather than the exception to devote the first half of the year to arranging preliminaries which should have been cleared up during the winter. We do not doubt that not a few shortcomings of this kind will come to light a little later on in the present year of grace, but improvement is noticeable, and for such improvement the contracting community is truly thankful.

As a matter of fact there is no excuse for dilatoriness of this kind on the part of municipal officials, and where the legal formalities and other preliminaries connected with public works are extended well on into the spring the responsibility should be established and the authorities made answerable to the ratepayers.

There are many reasons for securing bids well ahead of time,—reasons which are so patent that it would appear purposeless to recount them, but we cannot refrain from emphasizing the fact that in the slack winter season contractors have all the time at their disposal to submit carefully detailed bids and afterwards make their arrangements for carrying out the contract. The advantages, moreover, are evenly divided between the contractor and the municipality. We learn that the Maryland State Roads Commission in response to an advertisement for proposals on six contracts, aggregating about thirty miles of road, received tenders from forty to fifty contractors, representing in all nearly one hundred bids. This illustrates very strongly the ensuing advantages of keen competition and the resultant lower prices.

Reports from all sections of the country, in every department of constructional enterprise, indicate that the season of 1914 will be one of exceptional activity and we would strongly urge upon those who have been dilatory as regards the preliminary details of any engineering and building project to make up for lost time and to publish their advertisements for tenders before the responsible firms are loaded up to capacity and are too busy to consider any more jobs—except at a fancy figure.

The Example of Duluth

COMPANIONSHIP in misery has often sustained an individual and nerved him to fresh endeavor. This is a matter of history, not of philosophy. The thought comes to us upon hearing that the city engineer of Duluth, Minn., has resigned on account of unjust and malicious criticism of his department. The news hardly brings with it a measure of gratification, for two wrongs do not make one right and no individual betterment is brought about by a knowledge of the discomfiture of others. Nevertheless, there is a modicum of comfort for municipal engineers in Canada in the reflection that bad and undesirable as are the conditions under which they live and have their being, at least they are as bad elsewhere. The "retiring" city engineer of Duluth submitted a letter of resignation which almost rivals the last records of the great Captain Scott in its simple, telling force. He condemns the wanton persecution of city officials and deplores the kind of criticism which is the outgrowth of ulterior motives. There is a note of self-reliance in his statement that he has no apologies to make. There is a considerate thought for his successors in his commendation of his staff and his plea for their encouragement.

The resignation of Duluth's city engineer seems to have attracted some little attention—possibly because the conditions which gave rise to it are unusual. We cannot but feel concerned as to what would happen if the municipal engineers of Canada were to resign on the ground of malicious persecution or ignorant opposition. Trailing along somewhere behind the name of engineerless Duluth would be the names of practically every municipality in Canada, if an honor list were compiled. We may congratulate ourselves that one-half of the city and town engineers in Canada do not follow the example of Mr. John Wilson, of Duluth,—and wonder why they don't. Perhaps it is because they have something of the spirit of Omar:—

> "Unborn to-morrow and dead yesterday:
> Why fret about them if to-day be sweet?"

Valuable Report on Pollution of Water Supplies

> "The position of intake and the pollution existing in the vicinity of municipal water supplies are such that there is not a municipality using lake water which can be said to possess a safe water supply without treatment. . . . . In certain localities the pollution is so great as to impose an unreasonable burden upon any known method of water purification."

FULFILLING the obligations of a treaty between Great Britain and the United States, whereby the pollution of the boundary waters of Canada and the United States was prohibited, an investigation has been made by an International Joint Commission, an abstract of whose report is printed elsewhere in this issue. The present report is confined to the extent and causes of pollution.

At the time of writing we are informed by the Ontario Health Department that copies of the report, with the accompanying maps, are "still in the printer's hands," and so we owe our information to The Engineering Record whose editorial on the subject (abstracted below) contains many suggestive points:

"The report shows a very painstaking and thorough examination of the extent of bacterial pollution. The commission finds that the great bulk of the water of the Great Lakes remain in its pristine purity, but that dangerous sewage pollution exists at certain points in the lakes and in the connecting waterways. Most of this comes, of course, from the sewage discharge of cities, and some from steamboats. The commission also finds that practically all drinking-water supplies from the lakes must be adequately purified to make them safe; they also find that where pollution is great, hypochlorite treatment is often ineffective.

"On the basis of their investigations the next problem before the commission is to determine 'in what way or manner it is possible or advisable to remedy or prevent the pollution of these waters' within the limits of the intent of the Treaty of 1909. This is indeed a large problem of many aspects. The basic question is whether or not the boundary waters shall be maintained in such condition that they shall be suitable for drinking water supplies without any purification. That such a uniformly high standard is in all cases possible of attainment is very much doubted, and if it should be possible it would not always be worth the effort. A very well balanced statement may be found in the report of the British Royal Commission on Sewage Disposal, for 1908, in referring to their river waters. It may be equally well applied to our boundary waters. That commission states:

" 'We are satisfied that rivers generally, those traversing agricultural as well as those draining manufacturing or urban areas, are necessarily exposed to other pollutions besides sewage, and it appears to us therefore, that any authority taking water from such rivers for the purpose of water supply must be held to be aware of the risks to which the water is exposed, and that it should be regarded as part of the duty of that authority, systematically and thoroughly, to purify the water before distributing it to their customers.

" 'Apart from the question of drinking waters, we find no evidence to show that the mere presence of organisms of a noxious character in a river constitutes a danger to public health or destroys the amenities of the river. Generally speaking, therefore, we do not consider that in the present state of knowledge we should be justified in recommending that it should be the duty of a local authority to treat its sewage so that it should be bacteriologically pure.' "

"On the other hand, there may be places where pollution is so gross that an undue burden is placed on water purification plants, and the best of these plants may at times fail to make the water absolutely safe. For such conditions the sewage should be subjected to such reasonable amount of treatment as to leave the water, while not pure from a bacteriological standpoint, at least reasonably clean, so that it can be readily purified for use as a domestic supply.

"The amount of such treatment is a matter to be determined after consideration of local conditions. It requires for each place a study of the amount and character of the sewage discharged, the amount of diluting water, the nature of the water currents, the effect of wind on these water currents, the effect of stratification and many other special features. It requires, too, a study of the costs of various purification methods when applied to the local conditions, and the results that can be obtained.

"Besides this careful engineering examination of the sewage treatment problems of these cities on boundary waters, the commission must very carefully consider the views of the officials and the people of the cities interested. It is fundamental that any rules established which are not in accord with the enlightened public sentiment of the communities on which they are imposed will fail of effect, and for the commission's efforts to lead to practical results it must consider this local public sentiment and see to it that its rules will be such that the municipal authorities and the taxpayers can appreciate their reasonableness.

"After such a detailed study of the special features presented by the various localities interested, of the amount of purification which can to advantage be insisted on, and its cost, the commission can formulate a general policy and a set of standards. These standards, to be general in their nature, ought to specify, not the degree of purification which the sewage discharge of any city under the diverse existing conditions must receive, but rather the degree of pollution which is to be permitted in the lake or river water into which the sewage effluent is discharged. A similar standard has been adopted by the British Royal Commission in its Eighth Report.

"A report to the National Association for Preventing the Pollution of Rivers and Waterways by its committee on standards, dated October 22, 1912, considers this problem in a very general way. The field work report of the commission gives the needed objective data on existing conditions. The next step is to get the views of the interested communities as to existing conditions, and their ability to better them. The final step will be to correlate these various data and opinions in the light of the best expert sanitary knowledge, and to establish an acceptable standard."

The Building Contractor—His Problems and Methods

CONTRACTING companies have not often made public the detailed methods used by them in organizing for and in carrying out their various contracts. The result is that there is considerable mystery surrounding the work of contractors, and owners and engineers have in some cases looked upon such men with suspicion, comments our Chicago contemporary, Engineering and Contracting, in an editorial article devoted to a consideration of a paper on the above subject by Mr. Leonard C. Wason, of the Aberthaw Construction Company, Boston. However, conditions are changing, and it is being realized that an efficient, organization and open dealings with owners and engineers are important assets of a company, and that the publication of construction methods used on particular jobs constitutes legitimate and profitable advertising. Further, the publication of this information should tend to cause engineers to adopt types of construction which can be erected economically. Some firms have failed because they did not appreciate the necessity of good business methods—others have not possessed sufficient flexibility in their organization to meet the changing character of work. Some have engaged in more work than their capital and equipment justified, and thus were not able to provide for emergencies. The willingness of some contractors to take work on a speculative basis has not given the best results, either to the contractor or to the owner, as both are entitled to a fair return on their investment.

Many companies are now glad to take work on a cost-plus-percentage-basis, which simply means that the speculative element is omitted and that only a fair return is expected. With this form of contract the contractor rents his equipment and organization and becomes the owner's broker in the purchase of materials; while the owner furnishes the capital required to provide for depreciation of the contractor's plant, the cost of labor and a fair profit. Contracting companies working on this basis must rely mainly upon their ability to give good service and to do reliable work in order to insure future contracts.

It is highly desirable to thoroughly understand the temperament of the owner, architect and engineer if harmonious work is to be done. Contractors soon learn what treatment to expect from certain architects and owners and govern their bids accordingly. It is evident that the attitude of the owner and architect has much to do with the progress and cost of the work. The importance and the difficulty of securing good inspectors is pointed out. It is not sufficient to get an honest inspector, but it is necessary to get one who is entirely familiar with the particular kind of work which he is to inspect.

The company with which Mr. Wason is connected favors the cost-plus-fixed-sum-for-profit form of contract, as such a contract makes the interests of owner, architect and engineer identical. To emphasize the fact that the contractor for building work is largely a broker it is stated that in office building work the contractor may not handle more than 1 per cent. of the contract price as direct labor, the remainder being for materials bought and for sub-contracts let. In reinforced concrete buildings the percentage of labor is about 35 per cent. of the total cost.

The best results can be secured only by perfecting a smoothly working organization and confining the contracts to what this organization can handle. There is great risk in taking on too much work and in employing superintendents and foremen for a single job. If work is done in widely separated cities it can not be efficiently handled by the main office, as incorrect methods can not be detected and corrected soon enough to be effective. The system of carefully analyzing the design in the main office and then planning and routing the work has many advantages. The making of detailed drawings for the forms by men skilled in this branch of the work—instead of allowing the carpenters to lay out the forms—has the advantage that the lumber can be ordered in such lengths and sizes that cutting is largely avoided. Further, better results can be obtained by this method, as carpenters capable of doing the highest class of work can not often be obtained for concrete work. It is important that special study be given to determine the rate of progress necessary to complete the building on time. The crowding of work when not absolutely necessary will require greatly increased expenditures for equipment and labor. Most contractors appreciate the desirability of an efficient cost-keeping system. However, all do not realize that a system which merely enables the contractor to determine the unit costs of the completed work has little value. A system to be of greatest value must be one by which unit costs can be determined as the work progresses. Such a system enables those in charge to determine what part of the work is costing too much, thus enabling them to correct defects in time to prevent large wastes.

Activity in Road Work

IN Eastern Canada, 1914 gives every promise of being a very busy year in road work. It is rather early as yet to attempt a detailed programme of what is planned in Ontario, seeing that the various government authorities throughout the province are only holding their initial meetings and that parliament has not yet met. From enquiries made by this journal, however, we may expect an expenditure about as follows: County roads, $900,000; Northern Ontario, $1,000,000; townships, $1,500,000; town and city streets, $7,000,000; total, $10,400,000. This is a conservative estimate from a conservative source and it may be accepted with a reasonable assurance of its accuracy. No less an amount will be expended on road work and street work in the province of Quebec, but it were too speculative to undertake an estimate of municipal and other local enterprises. We have definite information, however, that the government programme includes the construction of from 60 to 70 miles of macadam on the Montreal-Quebec road, 32 miles of macadam or gravel on the Sherbrooke-Derby-Line road and 93 miles of gravel on the Levis-Jackman road. In addition the Quebec government will supervise road-building in about 180 municipalities.

A 100-ton steam travelling crane for the Havre harbor works is described in "Engineering" of London. It was built by Cowans, Sheldon & Company, Limited, of Carlisle, England. It is capable of lifting, carrying and slewing loads up to 100 tons at a radius of 39 ft. 4½ in., all the motions being worked by steam power, at the following speeds: Lifting 100 tons, 8.2 ft. per minute; lifting 40 tons, 20.5 ft. per minute; revolving 100 tons, 1 r.p.m.; travelling with 100 tons, 32.8 ft. per minute. The carriage is built up of steel plates and angles, and travels on eight centre-flanged cast-steel wheels which run on rails 19 ft. 8¼ in. centre to centre. All motions are worked from one set of horizontal engines with two cylinders, steam being generated in a vertical boiler.

LETTERS

"Engineering Responsibilities"

New Glasgow, N.S., Feb. 5, 1914.

Editor Contract Record:—

I believe with you that failures for which the municipal engineer is blamed are due not infrequently to the interference of city councilmen and public works boards.

The engineer in private practice is often blamed for the failure of designs in which directors of corporations and other individuals have interfered, for financial or other reasons. Last of all the general public itself interferes with matters and often uses its influence to cause trouble for the community and the engineer. Sometimes the press influences the public, to the unfortunate engineer's discomfiture. Most of your readers will readily think of one or more examples to illustrate each of the generalities above.

You contend that "a system which gives final authority in engineering matters to ill-informed politicians is fundamentally wrong." Granted that you are right, what about matters other than those of a purely engineering nature? Should your ill-informed politicians be the final authority in regard to sanitation, police, fire-protection, education, etc.?

It is indeed lamentable that better educated and more capable citizens cannot be induced to act as public representatives. It is a pity, too, that when such men occasionally seek election, ward politics often prevent their nomination.

There is a good point in the organization suggested for the city of Montreal—the six-year period of office proposed. Ordinarily the municipal engineer is appointed for only a year, or two years at the most. He may be a capable civil engineer, especially efficient in municipal engineering, and may work faithfully and to the best of his ability; but if he does not pay proper attention to the views of your "ill-informed politicians," his tenure of office will certainly not exceed the usual period of appointment. For the sake of maintaining his position, therefore, he will sometimes see things in a different light than he would if he were not influenced by such considerations.

The working out of the city-commissioner and city-manager charters will be watched with interest by municipal engineers. The city commissioner or city manager may become a despot in contrast to the present city engineer, who, as you say, is "only a servant taking instructions." But this may be better for the welfare of the city than the present arrangement; for, after all, in matters of an engineering nature, a benevolent despotism may be better than a perverted democracy.

Yours truly,
DONALD F. McLEOD.

The Montreal Water Famine

Editor Contract Record:

Your leading editorial in the issue of January 14 has interested me greatly. It is only by failures and disasters, whether they be attributable to lack of technical skill or blundering administration, that the great lessons of a new and growing country are ever learned. How is it that there are so few failures in the public works of Great Britain and Europe generally? Surely there must be some well-defined reason! Is it because the system of municipal government over there is better, or is it because of the fact that before an old country engineer is placed in charge of responsible work he is required to have had careful training, long experience and association with one of the national engineering societies? Or,—in the case of Great Britain, is it because of the existence of the Local Government Board, which acts as a brake on all municipal expenditures and undertakings. It is such things as these that flash across the mind of an engineer who has been trained in Great Britain as he reads of the constant failures of engineering work and municipal administration in Canada.

In my opinion the present unsatisfactory record will be continued until the inauguration of a new system of government and I beg to offer the following suggestions, namely; that

(1) All councils be elected so that an entire change take place in three years, the Mayor to be elected from the council, thus ensuring his previous experience before taking office.

(2) All officials, such as treasurer, auditor, sanitary and building inspectors and city engineers be required to pass a qualifying examination before holding office, such officials to be approved by the controlling governing body and their duties set forth in a universal by-law, thus placing them out of the reach of the ordinary politician.

(3) A regulating body, either Dominion or Provincial, be formed to investigate and approve of all loans and schemes over a certain amount.

(4) Projects of large magnitude receive the approval of a qualified engineer of recognized reputation.

I must refrain from criticizing the Montreal failure, as my information has been acquired only from the papers. The point I wish to make is that there is something radically wrong with municipal administration throughout Canada, and I hope that before long steps will be taken to prevent a further waste of public monies. Much could be said upon this subject, but I feel that I have trespassed sufficiently upon the space of your valuable paper.

Yours faithfully,
"A City Engineer in Western Canada."

"A Building Can Only Contain a Certain Amount of Material."

Boston, February 4, 1914.

Editor Contract Record:

The dissatisfaction with present conditions which is the cause of the letters on "Gratuitous Bids," "Competitive Tendering" and "Fair Play to Contractors" has its source in the very large unnecessary expense to which contractors are put in making up tenders for construction work. The contractor who wishes to bid on a large job has to put in at least a week of continuous work if he wants to make a careful estimate, and the chances are that the more careful his work the less likely he is to secure the job, as a large number of contracts are let to bidders whose prices are considerably below the average of those tendering. General experience shows that such low bids are due to the tenderer's having left out some item of importance, the cost of which has to come out of his profit or else out of the job.

The editorial quoted from the "Surveyor" (Contract Record, Jan. 21, p. 66) hardly appreciates the burden of the expense of making bids that falls upon contractors in this country, as in Egland contractors are always furnished with a schedule of the quantities of labor and materials required in the work, and all they have to do is to price out these quantities and bring the extensions to a total. The time required to make up a bid is often less than two days, and the consequent expense to the contractor very much less than that of his American confreres.

There seem to be two remedies for this state of affairs. One, which has appeared in your columns, is that the contractor should be paid for submitting a bid. It seems to me that the objections you have quoted would be sufficient to rule this out of consideration at once. Another way would be to adopt some system of furnishing schedules of quantities to the contractors tendering. The tenders need not be on unit prices, as if the quantities were correct there should be no reason why a lump sum bid could not be given, and if one independent party calculated the quantities for all parties tendering, the competition between the bidders would be limited to a competition in price, not in quantities.

As matters stand to-day, contractors are guessing against each other as to the quantities of material in the job, and if there are twelve bidders twelve men will have had to make a complete survey of the plans of a job that could just as well have been made by one. When bidders are invited to tender it is supposed that they are submitting competitive prices, but actually their bids are based upon competitive quantities before competition in price commences. This seems to be not only unfair but absurd. A building can only contain a certain amount of material and no amount of figuring by contractors against each other can make that quantity any more or less. If a bidder, through being hurried, or misled, perhaps, by plans that were not clear, leaves something out, he secures the job and the owner benefits at his expense, while the more careful man loses the job because his work is more accurate.

There seems to be an awakening interest in this subject among architects and contractors, and a society has been formed in San Francisco called the American Institute of Quantity Surveyors which is interested in this matter and is endeavoring to establish an American system of quantity surveying. A good deal of preliminary work has been done and it is hoped that before long the present unfair conditions of tendering will be largely ameliorated.

Yours very truly,
LESLIE H. ALLEN[*]

Instructions to Building Inspectors

THE subject of inspection in building construction is discussed very fully in a paper by Martin Schreiber. It is a department in which we are deplorably weak and the following instructions, given by Mr. Schreiber, may be found of value as defining the duties and responsibilities of a competent inspector:

(1) Carefully study all plans, elevations or other drawings; also all specifications, and see that the drawings are in conformity with each other and with all the specifications.

(2) Check all figures and dimensions on plans and details; check shop details as they are received to see that they do not conflict with scale drawings. Check all erection diagrams in order to recommend some other procedure in an emergency, should the necessity occur. Also see that the specifications, or special intentions, agree.

(3) Keep on the work, in an accessible location, special copies of all drawings, details and specifications, and carefully note on same any changes from original plans, so as to keep a complete record of the work as constructed.

(4) Familiarize yourself with all local conditions or ordinances affecting the work and see that same are rigidly adhered to.

(5) Make the acquaintance and keep in touch with the General Contractor and all sub-contractors.

(6) Establish diplomatic relations with adjoining property owners, or residents, and see that all their rights are respected by the contractors.

(7) Acquaint yourself with all traffic arrangements, whether regular or special, that may interfere in any way with the progress of the work.

(8) Secure full information concerning the conditions of steel work being fabricated in the mills or shops; also of any other materials that may be under the course of construction, and ascertain the names of all contractors, dates of orders and the probable date of shipment, and, if necessary, closely follow up same in order to secure proper delivery.

(9) Should any incomplete work be fabricated that will need attention and correction at the site, carefully look out for and see that all corrections are made before same is incorporated in the structure.

(10) Keep a record of the arrival of all materials. The contractor's record should be sufficient, if suitable; but should be carefully checked. Strive to anticipate any shortage of material and use all available facilities to hasten delivery; also arrange for the proper storage of same on the site.

(11) Try to anticipate the need of detail drawings and notify the engineer or architect regarding same.

(12) Study the progress of the work and try to determine whether it will be completed in the specified time, and, if in your opinion it will not be finished as specified, endeavor to secure such additions to force and equipment as to secure completion within the allotted time.

(13) See that the company's photographer is informed as to the progress of the work, and that "progress photographs" are taken at least every ten days.

(14) Keep a daily record of the force employed and the distribution of labor in such a manner that will clearly show the progress of the work, and also of all equipment in use, at all times.

(15) When "unit prices" are called for, make a careful report of the cost of all material and labor which are included in same, separate from each other.

(16) Make careful preparations so that the erection may proceed rapidly and that the period of any disturbance or delay may be reduced to a minimum.

(17) See that all piping or sleeves for same are built through walls and that all other piping conduits, etc., are in place before any floors are laid or masonry built; also see that all chases or recesses are left in walls to receive piping, etc.

(18) Keep in close touch with the engineer or architect and consult with them frequently as to the interpretation of all drawings or specifications.

(19) Exercise a constant supervision of any sheet piling, underpinning, or forms for concrete, or any other falsework or temporary structure, and see that same is properly maintained, and not removed until all masonry is set.

(20) Carefully observe surface and sub-surface conditions, and see that all excavations are shored or sheet-piled where necessary. If surface drains are needed, see that same are installed in advance of masonry. Be sure that all waterproofing is thoroughly jointed and lapped. Do not allow back-filling against green walls, unless same are braced; also see that all back-fill is well puddled.

(21) See that all machinery and boiler foundations are built true to detail. See that all stone or terra cotta work is perfect before same is placed in the work; also see that all brick or other mason work is laid and anchored as specified. Be careful and see that all concrete work, whether reinforced or otherwise, is constructed as specified in all particulars.

(22) See that all furring is in place and firmly secured before work is started and that sufficient time is given to dry out between coats, and that a proper backing is prepared for all tile and marble work.

(23) See that all work is carefully aligned and accurately fitted. Closely watch all riveting and see that same is tight; also closely watch the painting of all work.

(24) Carefully examine all work before same is installed; see that all framing is accurately made and anchored and all roughing and furring is built in. All finished work should be

---

[*] Aberthaw Construction Company.

carefully inspected as to design, finish, etc.; if necessary, make "mill inspection"; trim must not be applied until plastering is dry. See that all hardware is properly attached, including that to metal-covered work.

(25) See that all flashings are carefully built in.

(26) See that the grades of pipes are uniform, properly supported and that all plumbing work conforms with the requirements of the local authorities. See that all joints are carefully made and are water-tight.

(27) Keep careful account of any extra work, in order to be able to explain satisfactorily, and check all extras. Keep a daily record of the progress of the work, including force employed, in a separate field book for each job. Note in same if any disputes arise, their settlement; also variations, if any, from the plans or specifications; at completion of the work, correct all plans and specifications to agree with work, as constructed, and make a final report showing costs, where required.

(28) A careful and complete record in detail must be kept of the cost of all alteration or repair work, wherever work of this nature occurs in any part of the construction. Also a detail of the cost to reproduce any and all structures that may be torn down, removed or otherwise destroyed shall be kept; and a report in full shall be sent immediately to the engineer.

The Proposed Second Narrows Bridge at Vancouver

THIS structure, so long contemplated, is now in a fair way of being erected. As the name implies, the bridge is to cross Burrard Inlet at the Second Narrows, three miles from the First Narrows at the entrance to the inlet.

The bridge is to have a swing span 581 ft. 6 in. in length between bearings, longer than any swing bridge yet built, two main spans 232 feet centre to centre of bearings, with 29 spans of steel trestling for the railway and 15 spans also of steel trestling for the roadway and sidewalk on the north side. The south approach to the end of the swing span for the railway is 250 feet in length and the roadway is 180 feet, with clear spans of 108 feet over the Canadian Pacific Railway. The total length of bridging for the railway will be 3,449 feet and for the roadway, 2,364 feet.

There is to be a single track for a steam railway, a roadway of 37 feet 5½ inches between curbs, with two central tracks for electric cars and an 8-foot footway bracketed out from the easttrn trusses. The width of the bridge from centre to centre of trusses will be 59 feet 6 inches.

On the south side of the Narrows the ground formation is a soft sandstone and rock, extending out to mid-channel and dipping under the gravel and detrital formation on the north side where Seymour Creek has been forming a delta. The depth of water in mid-channel is 96 feet 6 inches at ordinary spring tides, extreme tides running up to 100 feet nearly.

The swing span is to be carried by four wrought steel cylinders braced together and filled with concrete, spaced 49 feet centres in both directions. When closed the southern end will rest on a pair of wrought steel braced columns re-strung on a pair of cylinders spaced 59 feet 6 inches centres and on the northern end on braced wrought stel columns restrung on the ends of a solid pier extending the full width of the bridge. The piers north of mid-channel will be founded on the coarse gravel overlying the rock, that nearest the channel being carried down below the level of the bottom of the channel. The north arm of the swing will be placed over the fairway which is situated south of mid-channel. The bridge is to give a clear headway of 45 feet above high water of ordinary spring tides and a clear waterway on each side of the supporting pier of 225 feet measured square to the line of the span in the open position.

The bridge crosses the channel at an angle of 75 deg. to the average direction of the ebb and flood currents. The line of the swing when open follows the contour of the bed of the Narrows, and affords a minimum depth of 35 feet at low water through the south opening. The bridge dolphins will consist of six cylinders on the line of the span when opened, with heavy timber fendering.

The swing span is to be electrically operated, with hand gear for standby. The locking of the bridge closed and the opening and closing of the gates are also electrically controlled, as well as the signals for traffic and navigation—the whole controlled from an operating cabin in the usual manner.

The trusses of the swing and main spans are to be of the Warren type with vertical suspenders. The north approach is to be carried on steel braced trestles spaced longitudinally 29 feet centres and 43 feet 6 inch centres between the bents of the adjoining trestles. Transversely the bents supporting the steam track will be spaced 8 feet centres at the top with a batter to the bases of 1 in 4½. The bents for roadways and electric car tracks and footway will be vertical and spaced 26 feet centres, all supported on concrete foundations.

A series of borings made on the tide flats on the north side on the proposed line were sunk to a maximum depth of 160 feet showing alternate layers of coarse and fine gravel. On the south side the rock formation gives a good foundation.

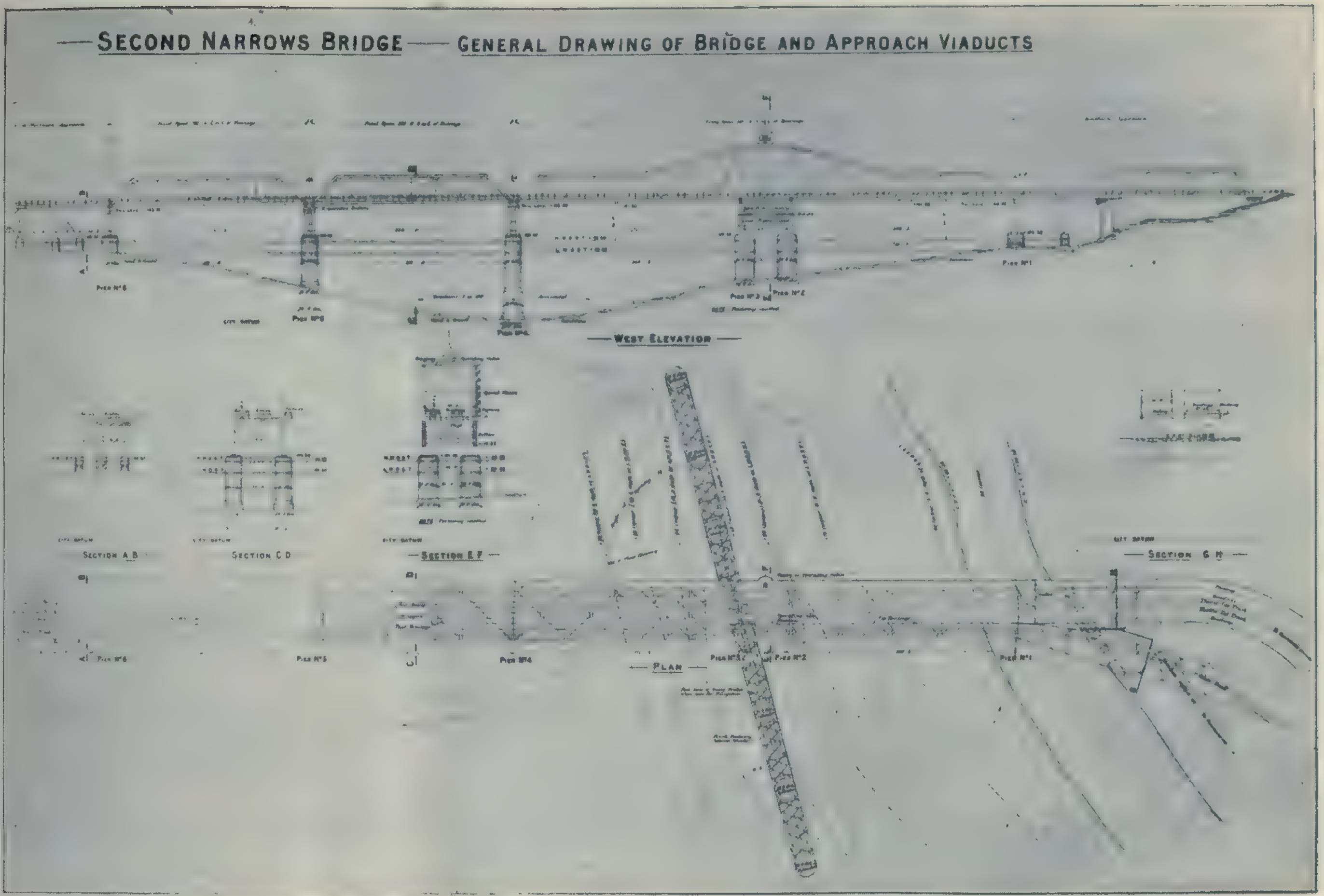
The design is for a complete structure to span the inlet. The south approach is partly in cutting and embankment and from the end of the trestles on the north side by banking to ground level.

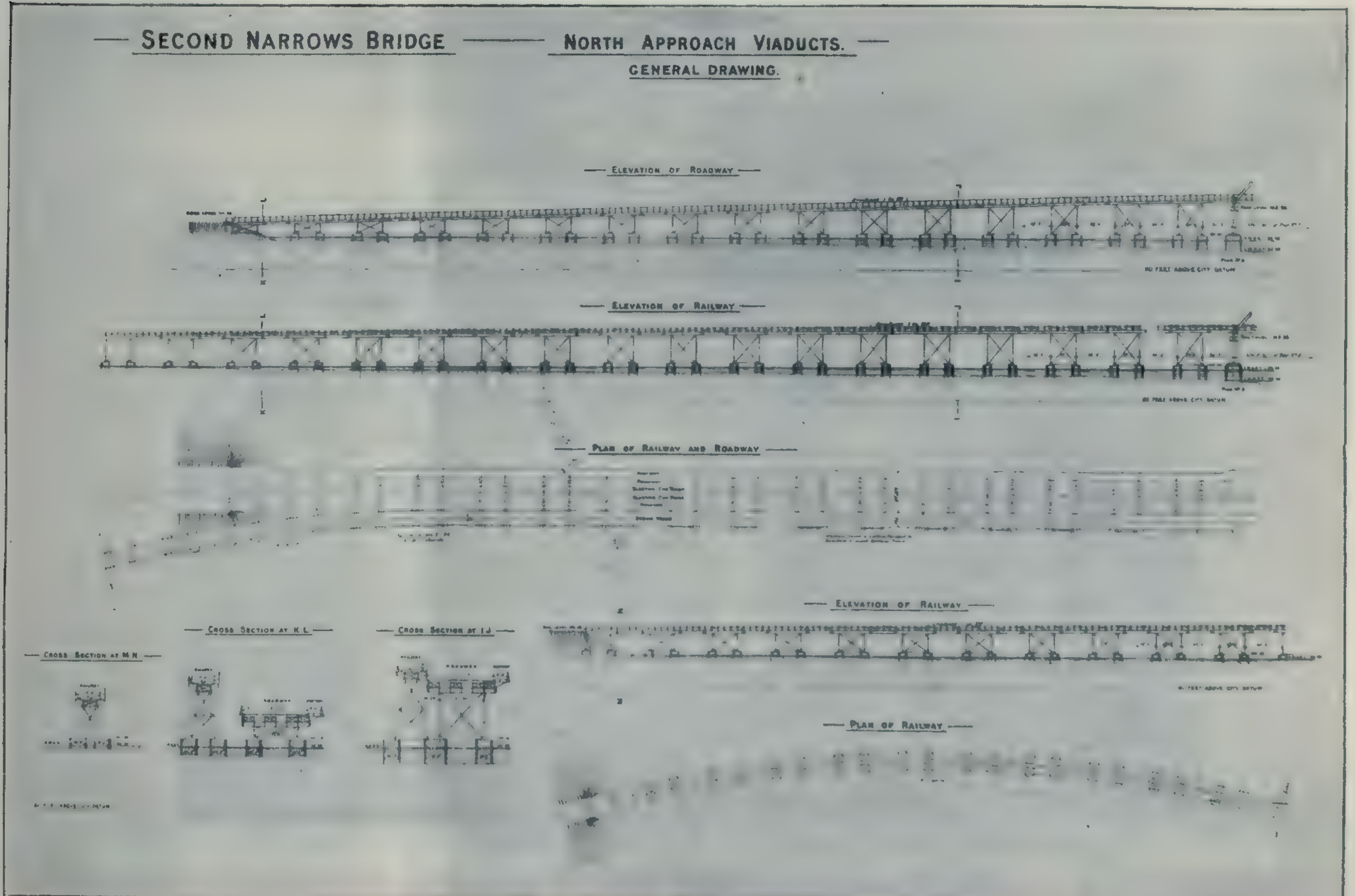
The bridge will give access to Vancouver from North Vancouver to the Pacific Great Eastern Railway. The electric car interurban traffic is fully provided for, with ample traffic road and footway accommodation.

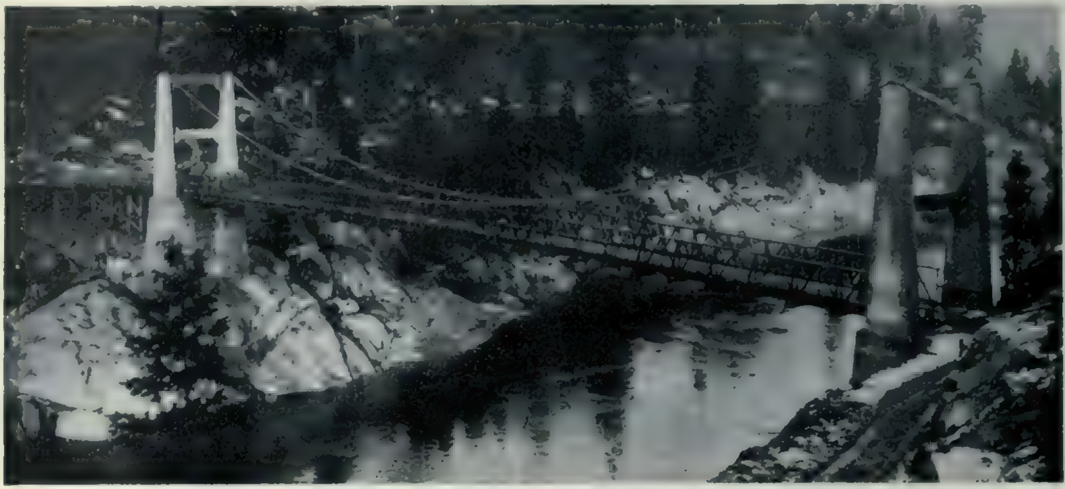
The bridge is designed according to the requirements of the Dominion Department of Railways & Canals, and the work will be manufactured in conformity with the specifications of the Department.

The Engineers for the bridge are Sir John Wolfe Barry, Lyster & Partners, of London, Eng., with whom is associated the Vancouver firm of Cleveland & Cameron.

Messrs. John R. Freeman, W. R. Burr and Alfred Noble, consulting engineers in connection with the Catskill Aqueduct, have asked that their salaries be reduced from $6,000 to $3,000 per annum each, on the ground that the bulk of their work has been completed. The unusual request has been granted.


SECOND NARROWS BRIDGE — GENERAL DRAWING OF BRIDGE AND APPROACH VIADUCTS
WEST ELEVATION
PIER No 6
PIER No 5
PIER No 4
PIER No 3
PIER No 2
PIER No 1
CITY DATUM
ERECTION
SECTION A B
SECTION C D
SECTION E F
SECTION G H
PLAN


SECOND NARROWS BRIDGE — NORTH APPROACH VIADUCTS.
GENERAL DRAWING.
ELEVATION OF ROADWAY
ELEVATION OF RAILWAY
PLAN OF RAILWAY AND ROADWAY
ELEVATION OF RAILWAY
PLAN OF RAILWAY
CROSS SECTION AT M N
CROSS SECTION AT K L
CROSS SECTION AT I J
80 FEET ABOVE CITY DATUM

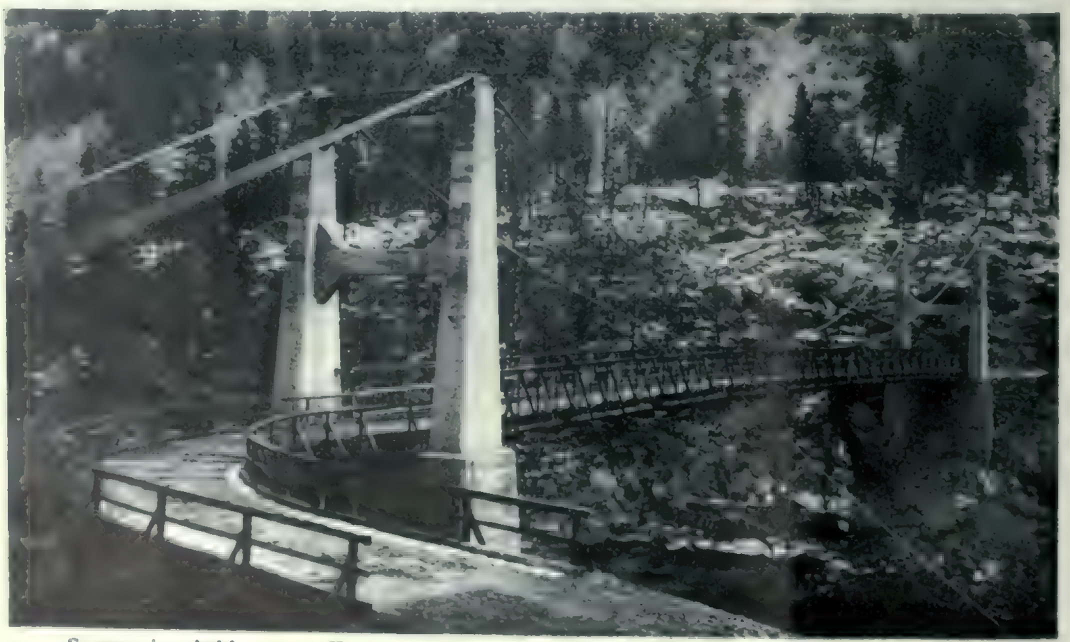


Suspension bridge over Kootenay River. From the South bank.

New Suspension Bridge Spanning the Kootenay River

THE thriving colony of Brilliant, situated at the confluence of the Columbia and Kootenay Rivers, in the West Kootenay District, comprises the principal settlement of the Doukhobor society in British Columbia, most of the villages* in the settlement being separated from the line of the Canadian Pacific Railway by the two rivers mentioned.

Owing to the rapid development of the district in the last few years, the need of a substantial bridge for the purpose of affording communication with the surrounding country became imperative, and it was decided recently to erect a structure of the suspension type to span the Kootenay River at this point. An excellent idea of the class of bridge erected may be gathered from the views accompanying this article, the work having been designed by and constructed under the supervision of Mr. J. R. Grant, of the firm of Cartwright, Matheson & Company, consulting engineers, Vancouver, and built by the Doukhobor society, with the financial assistance of the provincial government. The cables, towers and anchorages were designed for a total live load of 155 tons, while the trusses have been designed for a live load of 60 lbs. per square foot for the chords and 80 lbs. per square foot for the



Suspension bridge over Kootenay River. From the C.P.R. tracks on the North side.

---

* A Doukhobor village consists of two dwelling houses, with outhouses, in which reside from six to ten families.

diagonals, the floor being designed to carry the weight of a 26,000-lb. traction engine, several of which are owned by the society. The bridge has a clearance of 45 feet above high water. The span is 331 feet from centre to centre of towers. Below the site of the bridge the river has a width of over 500 feet. The structure itself has a clear width of 16 feet, and the roadway consists of 3-inch plank on nine lines of 3 x 14-in. Douglas fir joists, the floor beams being spaced 11 ft. 6 in. from centre to centre and built up of two 12-in. channels at 20½ lbs., placed 1½ in. back to back, 1¼-in. diameter hanger rods passing between them. The steel stiffening trusses have a depth of 9 feet, the top and bottom chords being built up of two angles 6 x 6 x 7/16 ins., while the diagonals are each of two angles 3½ x 3 x 5/16 ins. The top chords are supported laterally at each floor beam by knee braces, consisting of two angles 3½ x 3 x 5/16-in. The bridge is braced laterally by round rods varying from one inch diameter plain rods to one and one-eighth inch diameter upset rods, and by guy cables of 1⅜-inch galvanized plow steel wire rope with wire centre, attached at points 57-ft. 6-in. on each side of the centre of the bridge. Each of the main suspension cables consists of four 2-in. galvanized plow steel wire ropes, each composed of seven strands of nineteen wires. The sag is 37 feet and the cables are cradled one inch in 12 inches, giving a width centre to centre of saddles of 26 ft. 10 in. The hanger rods are attached by cotter pins through pairs of bent plates, which grip the ropes firmly together. Each saddle, consisting of a cast iron seat, with grooves for each rope, moves on a nest of eight 4-in. rollers on a steel base plate, the whole saddle being protected from the weather by a light metal cover. Each cable is attached by a steel socket of two 2¼-in. diameter bars which are anchored in solid rock. The top of the towers is 46 feet above the roadway and the two shafts forming a single tower are braced by cross girders with deep knee braces. These towers are constructed of concrete, mixed in the proportion of one portion of cement to six of aggregate, and are reinforced with plain round rods. The piers are constructed of rubble concrete mixed in the proportion of one part of cement to seven and one-half of aggregate and contain between 40 and 50 per cent. of large stones.

The difficulties encountered during the course of construction will be appreciated when it is explained that all the laborers employed were members of the Doukhobor society, who were unaccustomed to work of this character, and, with few exceptions, unfamiliar with the English language. On account of these conditions Mr. A. M. Truesdell, the resident engineer of the work, was compelled to remain constantly at the site during the entire progress of the operations, most of his instructions being by means of an interpreter.

Avoidable Defects in Concrete Paving

By Frank F. Rogers

CONCRETE can no longer be regarded as in the experimental stage as a surfacing material for county roads and on certain streets for city and village pavements. It has long been accepted as the most suitable material for the foundation of pavements for city streets, no matter what material is used for the wearing surface. There has been a great deal of discussion, however, as to its suitability for a paving material when used for both foundation and wearing surface.

Unfortunately most of what has been written both for and against concrete for road surfaces has come from persons directly or indirectly interested in the sale of cement, or on the contrary, interested in the promotion or sale of some other materials for surfacing both city pavements and country roads. Under such circumstances, no matter how honest the writer may attempt to be, his arguments and conclusions almost invariably coincide with his interests. We have Scripture for it, that "where the treasure is there will the heart be also."

The last five years have seen an immense yardage of concrete pavements laid in the cities and small towns of the country and a rather large mileage of concrete laid on country highways. Michigan, Wisconsin, Illinois and Iowa are the states which seem to have been most active in this work.

The writer has observed pavements built of this material in many cities, and has seen all the concrete roadways that have been built in Michigan, possibly 75 miles in all. A paper giving the results of a rather minute study of some thirty miles of the concrete roadways in Wayne County, Mich., was prepared by him for the American Road Congress recently held at Detroit, but as this paper has been published in full in most of the engineering journals no further reference will be made to it at this time. As to the pavements, it must be said that a few of them are without defects, but most of these can be traced to the following causes: (a) Too lean a mix; (b) A poor aggregate; (c) Poor foundation, including inadequate drainage; (d) Lack of suitable expansion joints properly spaced. And it should be added that about all of the observed defects in concrete roadways can be traced to one or more of the above causes.

Look Out For Lean Mix

A large percentage of the defects in city and small town concrete pavements may be charged to a lean mix, especially where two-course concrete has been laid. There has been much talk about satisfactory pavements of this kind at a cost from 75 cts. to 80 cts. per sq. yd. Any attempt to build concrete pavements or roadways at these prices is a sure bid for failure. Under favorable conditions and with careful workmanship the writer believes that the two-course pavement can be made a success. If so the top layer must be put on before the bottom layer has had time to take the initial set, and the mix should not be leaner than 1:2½:5 for the base, nor than 1:2:3 for the top. I would prefer a one-course concrete with a 1:2:3½ mix, taking great care in the selection of the aggregate both as to hardness and toughness of the crushed rock or pebbles, and in the proper grading of both the coarse and the fine aggregate so that the utmost possible density would be secured.

Experience thus far has convinced the writer that it is much easier to secure a satisfactory cement than to secure a suitable aggregate. Results in Wayne County seem to favor washed pebbles and sand rather than crushed cobbles for aggregate. This is rather hard to account for when one considers that the pebbles represent about the same variety and character of rocks that we get in our cobbles. It is quite possible that a better gradation from fine to coarse is secured with the pebbles, thus making a denser material. No matter what the theory, there can be no question that the pebble concrete makes the most durable surface and one which wears more evenly than others.

In the accelerated tests on two sections of concrete and two sections of brick made at Detroit during the recent Road Congress, the concrete in which Wisconsin granite, a rock as hard and tough as most traps, was used for the coarse aggregate, wore much better than the section where washed pebbles were used. It should be stated, however, that the price of Wisconsin granite delivered in Michigan is too high to allow it to be extensively used as an aggregate either for concrete pavements or roadways. The only materials that are commercially available at prices that can be considered are washed pebbles, crushed cobbles and limestone. So far the latter has been used but little for road purposes, but I am of the opinion that the best grades of lime rock are worth considering in this connection, especially on the secondary roads. The limestone (which is a dolomite) would at least wear evenly which is not true of the cobbles owing to the varying degrees of hardness and toughness in the different varieties of rocks found among the cobbles in our state.

Watch the Foundation

To avoid cracks the foundation must be absolutely stable and free from water at all seasons of the year. Where old travelled highways can be used for the foundation with only enough changes of surface to make a smooth sub-grade, the conditions are ideal. Where such conditions are found in Wayne County long stretches of roadway 15 ft. and 16 ft. wide may be seen, perfectly free from longitudinal cracks. On the other hand any cut or fill more than 1 ft. or 2 ft. in depth is almost sure to produce longitudinal cracks in the concrete, unless it is very narrow.

Experience has proved that from 25 ft. to 33 ft. is a suitable spacing for transverse joints. By way of experiment a 150-ft. stretch of 16-ft. roadway was laid on Michigan Ave., Wayne County, this year without expansion joints of any kind. Before the road was opened to traffic nature had supplied the transverse joints spaced from 18 ft. to 26 ft. with one extra thrown in for good measure.

Any kind of crack except the expansion joints in a concrete roadway is some reflection on the design, workmanship, or material. There is no doubt that if all the knowledge we now have on this subject were utilized in design and construction, pavements and roadways of this material could be laid that would remain almost free from the defects named. There is some question, however, if to do so would not make the expense of the pavement or roadway so high as to be practically prohibitive. So far the cracks that have been found are not more difficult to handle than the expansion joints and apparently are not much more objectionable except for their unsightly appearance when repaired. However, if they should eventually become too numerous they would necessarily cause the destruction of the pavement or roadway.

The waterworks plants of Canada represent a cost of $95,566,496, according to figures compiled by the Commission of Conservation, Ottawa.

Permanency in Modern Road Building

By Iverson C. Wells[*]

THERE are two materials that make for permanent roads—granite block and vitrified clay brick. Either one of these materials is durable and wherever you see a road that has withstood heavy traffic conditions for years you will find that one or the other has entered into its construction. Roads of clay brick, built five hundred years ago in Holland, are still doing service today. Streets paved with clay brick in London three hundred years ago are still carrying the burden of the heavy traffic of the world's greatest metropolis. There are permanent road,—a highway that lasts only from two or three years is not a permanent highway, and yet the country is streaked with miles of just such roads because of a mistaken idea of economy.

In Cleveland, Ohio, and Cuyahoga County, the commonwealth in which Cleveland is located, there are several hundred miles of vitrified brick highways. Some of these were built more than a quarter of a century ago, but because they were constructed of permanent material they have not cost the taxpayers one cent in repairs and are good for many years to come. In Terra Haute, Ind., there are brick-paved streets that were constructed more than a quarter of a century ago and not one cent of repairs has been placed on them. They are as good today as they were when they were laid and they will continue to be of service for many years to come.

North Woodland Road, Cuyahoga County, Ohio. Laid in 1906. Fifteen feet wide, broken stone curbs, cement filler, concrete base.

Vitrified brick is artificial granite. Man converts clay into this artificial granite by the same process that nature uses in making its product—by the application of intense heat, only he accomplishes his work in hours where nature has taken thousands of years. Vitrified brick, being cheap, durable and obtainable almost anywhere, is a popular material.

While vitrified paving brick is a most durable road material, it must be used properly. Even a street or road constructed of Bessemer steel would give way if it were not properly laid. Poorly constructed brick streets or highways are not giving the taxpayer the full value of his investment. Built right, a brick street is as smooth as sheet asphalt, and it improves in this quality as the years roll by. The streets of Cleveland, some of the most exclusive boulevards being of brick, are proof positive of this statement. Properly constructed, a brick street is sanitary, is no noisier than others and has the advantage of being permanent.

---

[*] Of the National Paving Brick Manufacturers' Association.

There is but one method recognized by the National Paving Brick Manufacturers' Association for the construction of a No. 1 brick street or highway. Most of Cleveland's streets and the miles of highway in Cuyahoga County are built under the specifications indorsed by this Association. Briefly stated, this form of construction calls for—first of all—proper drainage for the roadbed. The roadbed must be rolled with a heavy steam roller. On top of this, six inches of concrete is laid and permitted to harden. A cushion of sand is placed on the concrete and this is well rolled to form a smooth base for the brick. On top of this the vitrified brick are laid and a cement filler, composed of one part Portland cement and one part fine, sharp sand, is poured between the interstices. On each side of the street expansion joints are placed and a curbing of either stone or concrete. In highway construction, four inches of concrete usually forms the base, as the traffic conditions on the country roads are not as severe as in the cities.

The U. S. Government has indorsed this form of construction and used it exclusively in its road construction in Panama. The authorities will build several miles of vitrified brick road in Ohio as a part of the great national highway system and as a model for similar construction work.

Contrary to the popular idea, brick-paved streets cost little more than, and quite often not so much as, the best constructed streets or highways of other materials. They have the economical merit of permanency and freedom from repairs.

Suggestions for the Utilization of Granite Block Pavements

By R. H. Gillespie, Chief Engineer of Sewers and Highways, New York

STONE in many forms has been used for pavements from the earliest times. The old Roman roads were constructed of solid masonry, in many cases as much as three feet in depth, consisting of irregular shaped stones with interstices carefully filled with smaller stones, and the surface finished smooth and true. These roads were wasteful of material but remarkable for their durability and excessive cost.

The earliest pavements laid in this country were of the cobblestone variety, consisting of bank or water cobbles, varying from four to nine inches in diameter, embedded in earth, attempts being made to lay the cobbles to a uniform surface. This style of pavement, while cheap, was remarkable for the noise produced by traffic passing over it, and it was also very severe on draft animals owing to the constant jar from the load hauled.

Following cobblestones came what is known as the Belgian block. This type of pavement was a marked improvement over the cobblestone, and many miles of it were laid in New York City and vicinity. The blocks were usually of trap rock quarried along the west bank of the Hudson river, and in size were from six to seven inches square on top, about seven inches in depth, with a bottom dimension slightly less than the top. They were laid without foundation other than a sand bed and joints. While Belgian block was an improvement on the cobblestone, still it was open to many similar objections. Like the cobble it was very noisy and severe on animals, on account of its roughness as well as offering poor foothold, partly on account of the shape of the block and partly on account of the smooth glass-like surface of the individual blocks when worn by traffic.

Following the Belgian block, came the "specification" Belgian, which differed only in that the blocks were oblong, similar in shape to the present day granite blocks, and were open to the same objections as the square block, except that they afforded a better foothold for horses. Next came the granite block, which combined the good qualities of the cobble and Belgian blocks, with desirable qualities of its own. On January 1, 1913, there existed in the City of New York 312 miles of granite block pavement. It is perhaps reasonable to believe that this type of pavement in its present improved form—and as it is likely to be further improved in the future—will increase rather than diminish in popularity. Its noisiness, which has been its chief objection in the past, is materially reduced in the improved block, and in view of the rapid increase in the use of rubber-tired vehicles this objection, it is predicted, will soon disappear entirely. The earlier pavements of the granite block type in New York City and vicinity were laid on a sand foundation varying from 1½ to 3 inches in depth; the blocks were from eight to twelve inches in length, 3½ to 4½ inches in width, and seven to eight inches in depth, so dressed as to lay joints not exceeding one inch. Later specifications reduced the maximum width of joint to ¾ of an inch. The pavement was then sanded, rammed and sanded again, and after all vertical joints were broomed full, the street was opened to traffic. In the early '90's a concrete foundation was provided for streets of particularly heavy traffic. The dimensions of the blocks, however, remained the same. On the concrete foundation was placed a sand cushion from one to two inches in thickness, and the blocks laid with all vertical joints filled with hot tar and gravel.

Early in 1911 the engineers of the various Boroughs of the city revised the specifications to provide for the so-called improved block. There was no concerted action, however, in this respect. Manhattan specified a block 7 to 11 inches long, 3½ to 4½ inches wide and 4¾ to 5¼ inches deep, dressed to lay ⅜ inch joints. The Bronx block was 6 to 9 inches long, 3½ to 4½ inches wide, and 5 to 5½ inches deep, dressed to lay ½-inch joints, while the Brooklyn block did not agree with either, with the result that the quarrymen were at sea and hesitated to get out large quantities of blocks in advance of actual orders.

Manhattan laid its first improved block pavement on Fourth Avenue, between 8th Street and 23rd Street. The Bronx on Teasdale Place, between Boston Road and Cauldwell Avenue—the former being a street of heavy commercial traffic, the latter a street of light traffic but with a 9.6 per cent. gradient. Each was laid under the specification peculiar to the respective Boroughs as to the size of blocks and dressing. The vertical joints of the Fourth Avenue pavement were filled with hot paving cement and coarse sand, and cost $3.55 per square yard including foundation; Teasdale Place with Portland cement grout mixed in proportion of one part cement and two parts Cow Bay sand, and cost $4.85 per square yard including foundation. The high price on this contract was probably due to the small called for (725 square yards). During 1912, large areas of this type of pavement were laid under the standard specifications for improved block. The reports for the year ending December 31, 1912, for Manhattan and The Bronx indicate these areas as follows:

Manhattan—Improved Granite Block	156,000 sq. yds. (7.52 miles)
Bronx—Improved Granite Block	54,975 sq. yds. (2.22 miles)
Manhattan—Special Imp. Granite Block ...	103,000 sq. yds. (4.17 miles)

the latter differing from the former in that the joints are ⅜ of an inch instead of ½ inch. All the Bronx improved granite pavements have joints grouted with Portland cement mortar, and all those laid in Manhattan are laid with paving cement and sand. The average cost, including a 6-inch concrete base, in Manhattan has been about $4.50 per square yard and in the Bronx $4.18 per square yard. Contracts are now in force or in preparation for extensive areas of this type of pavement.

Recently a granite pavement was laid in the Brooklyn Navy Yard similar to the Durax and Kleinpflaster block pavements of England and Germany. The blocks were manufactured in Salisbury, North Carolina, with an imported Sett making machine and were smooth and uniformly 2¾ x 3½ head dimensions. On account of this uniformity in size, the laying in concentric circles or segments as practiced in Europe had to be abandoned, and the blocks laid in straight lines or in arcs of circles of long radii. The pavement was laid on concrete with a cushion of stone chips ½-in. in depth, the joints were filled with the same material and poured with hot paving pitch. While this type of pavement has been used extensively in Europe and has given excellent results under heavy traffic conditions, it is believed that though it may be an economical pavement abroad, owing to the lack of quarries furnishing suitable stone and the necessity of making use of small fragments that cannot be used for other purposes, as well as the low cost of labor, that in this country where there are many suitable quarries, and where labor is very costly and entirely inexperienced in laying this type of pavement, the materially higher cost, as compared with the cost of improved blocks as at present laid, would hardly seem justified.

In 1908 the suggestion was made to the Bronx authorities as to the advisability of making use of the old granite blocks by splitting and redressing them. The scheme met with approval and a contract was gotten out for repaving Webster Avenue from 165th Street to 171st Street, with the result that an excellent pavement was obtained at very low cost. There has been practically no maintenance cost since the contract was completed, and the pavement at the present time is in very satisfactory condition. The blocks laid on sand, under the old specifications, are in most cases fully up to the length specified; in fact, a considerable proportion run from 12 to 14 inches in length and are rarely less than 7 inches in depth. The splitting and dressing consists in breaking the blocks running in length from 11 inches up, in two, using the broken face as the head and dressing the ends and sides to lay ½ inch joints. The finished blocks are from 6½ to 8 inches long, 3½ to 4½ inches wide, and 5½ to 6½ inches deep. Blocks shorter in length than 11 inches are reheaded where necessary, dressed to lay the required joints, and as a rule are used along the street railway tracks. As the blocks are dressed they are piled along the sidewalk until the concrete is in readiness for the pavement. The blocks are laid in the usual manner, in rows, at right angles to the curb line on a 6-inch 1:3:6 concrete foundation with a 1½-inch sand cushion. Up to November, 1913, 207,150 square yards, or 7.96 miles of this type of pavement had been laid in the Borough of The Bronx, all of it with vertical joints filled with Portland cement grout, at an average cost of $1.21 per square yard, exclusive of concrete base, as compared with an average cost of $3.20 per square yard for new improved granite block exclusive of foundation.

During the past four years all the improved and redressed granite pavements in the Bronx have been laid with joints filled with Portland cement grout, while in Manhattan and the other Boroughs they have been filled for the most part with paving cement or paving cement and gravel. The writer is of the opinion that under like conditions a thoroughly and well grouted granite pavement will give better results than one where paving cement and gravel are used. It is more easily cleaned, is apt to shed water more readily, is slightly smoother, and there is less tendency for the blocks to turtle back. There is one temporary but serious objection, while it lasts, to the grouted pavements, that should be noted, viz., the interference and inconvenience to business interests along the line of the street due to the time that the street must be kept free from traffic while awaiting the setting of the grout. This time should be, under the most favorable conditions, not less than one week. Still it is quite practicable to pave half a street at a time and thus to some extent minimize this objection.

For streets which are called upon to accommodate a large amount of heavy commercial traffic, the pavement of the granite block type, whether new or redressed, whether grouted or tarred, under the present specifications, will prove more economical and generally satisfactory than pavements of perhaps any other type on account of its adaptability to any grades, its non-slipperiness, its sanitariness, and its durability. Its chief objection, noisiness, as stated before, is eliminated to some extent by the use of a smoother block, and, further, by the advent and increasing use of rubber tired motor for iron-shod, horse-drawn vehicles.

A concrete hardening material now being introduced in the United States contains 95 per cent. iron dust, which is mixed with cement for finishing the surface of concrete floors. From 15 lb. to 25 lb. of the material is mixed with 100 lb. of the cement while dry, and one part of this mixture to two parts of sand makes the slurry for the top coat, which varies from ½ in. to 1 in. in thickness. It is said to make a hard and durable floor, which is waterproof and not slippery. The hardening material is used also to make new concrete adhere to old concrete in repair work.

Break in the Montreal Conduit and Method of Making Repairs*

A SERIOUS "blow-out" of a portion of the reinforced concrete conduit which conveys the municipal water supply of Montreal occurred on December 25,1913, and until January 2, 1914, when the conduit was again successfully placed in service, the city was plunged into the confusion and distress incident to a partial water famine. An official report on the cause of the break and the general condition of the conduit is being prepared, at the instance of the proper city officials, by J. A. Jamieson and P. W. St. George. The gist of that report will be presented to our readers when it becomes available for editorial use. Pending the receipt of the report mentioned we have prepared the following statement relative to the failure of the conduit and to the methods employed in repairing it. The present article is based on information derived from various sources.

Section of Conduit.—Figure 1, herewith, shows a cross-sectional view of the concrete conduit which failed. Figure 2 is a diagrammatic cross-section showing the relative position of the old and new canals and the conduit.

The smaller canal shown in Fig. 2 was formerly used to conduct the water supply of the city from the St. Lawrence river. About five years ago the reinforced concrete conduit was built and since then the work of enlarging the first canal has been prosecuted at intervals. The new canal is to furnish water for power and industrial purposes. The primary cause of abandoning the old canal was that the water it carried was exposed to serious contamination.

The old canal had a width at the water line of 80 ft. and a depth of 8 ft. The old canal was widened to 140 ft. and its depth increased to 14 ft. under a contract awarded in 1910. Work on the canal widening was begun in 1877, long before the enclosed concrete conduit was thought of, but a change in plan soon led to the cessation of excavation operations and they were not resumed until after the concrete conduit was in use.

As shown in Fig. 1 the conduit is of the horseshoe type, the radius of the invert being 13 ft. The greatest inside height of the section is 7 ft. 3½ ins. and the greatest width is 9 ft. The inside width of the bottom segment is 7 ft. 2½ ins. The thickness of the concrete at the top and bottom is 8 in. and at the level of the greatest width of section it is 12 ins. The concrete is 1:2:5 mixture reinforced with No. 7 and No. 12, Birmingham gage, Clinton wire mesh, the larger strands being 4 ins. and the latter 12 ins. apart. The soil traversed by the conduit ranges from limestone to clay. The stability of the latter soil is dependent upon its moisture content. Where the surrounding soil was unstable the reinforcement extends entirely around the conduit section. Where the foundation was stable the reinforcement was carried 1 ft. within the outer ends of the bottom segment of the section. The size of stone specified for this construction was up to 1½ ins. in greatest dimension for the portion below the greatest horizontal width of the section and up to ¾ ins. in the balance of the section. It was further specified that the wire cloth should not at any point be closer than 3 ins. to the inner surface of the conduit. The capacity of the conduit is 50,000,000 Imp. gals. per day. The length is 27,300 ft. and the grade 1 in 5,000. When carrying the normal flow the hydraulic grade line is only from 5 to 10 ft. above the top of the conduit.

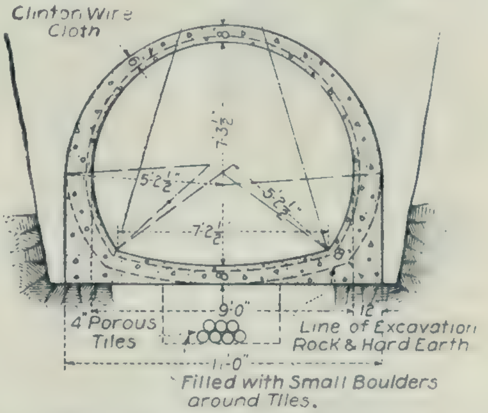

Clinton Wire Cloth
7-3½"
5-2½"
5-2½"
7-2½"
9-0"
12"
4" Porous Tiles
Line of Excavation Rock & Hard Earth
11-0"
Filled with Small Boulders around Tiles.

Fig. 1.—Typical cross-section of reinforced concrete conduit which failed.

The larger canal, shown in Fig. 2, was completed under a contract awarded in 1910, and almost as soon as this work was finished a further widening and deepening of the canal, to 174 ft. and 18 ft., respectively, was decided upon. This final enlargement of the canal section has been carried on by the Cook Construction Company. The new canal bottom is 5 ft. lower than the invert of the concrete conduit at the point where the accident occurred, and at that point the canal side slope is only 17 ft. from the conduit.

About the middle of December the contractor had about excavated the canal section to its full size at the point where the break in the conduit subsequently occurred. The excavation, which was in clay at this point, was made by means of a drag line machine which moved parallel to the canal. This excavating machine was a short distance from the conduit, the

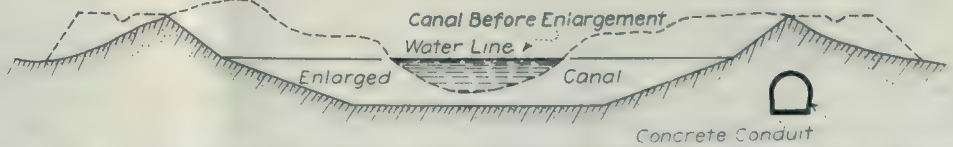


Fig. 2 —Montreal Water Conduit—Sectional diagram showing relative positions of old canal and its first enlargement and the water supply conduit.

(The second enlargement of the canal, which was under way at the point where the blow-out occurred, is 4 ft. deeper and 34 ft. wider than largest canal above shown.)

---

* Courtesy of Engineering and Contracting.

conduit being between the scraper and the canal. The scraper was on about 5 ft. of spoil from the canal excavation. This made the depth of filling over the conduit about 10 ft. At the time mentioned it was noticed that the conduit was leaking, so excavation operations were suspended. The leaking portion of the aqueduct was exposed and the cracks through which the leakage occurred were calked. Stone and sand for filling were also deposited back of a line of sheet piling set between conduit and canal. This repair work was completed two days before the blow-out occurred but, as developments indicate, it was of no avail.

A strip of the conduit concrete 60 ft. long and 2 ft. wide, on the canal side, gave way on the evening of Christmas Day. The conduit was, of course, soon emptied and Montreal was without an adequate supply of water until the evening of January 2. The conduit head gates were closed as soon as the break occurred.

Method of Making Emergency Repairs

A local iron works was given a rush order to get out seven 18 ft. lengths of riveted steel pipe, 7 ft. in diameter and ½ in. thick. While the pipe was being made the entire section of the conduit was torn out for the full length of the break. The bucket of the drag line excavator previously mentioned was used as a battering ram to break out the concrete. It took almost two days to clear away the portion mentioned.

The steel pipe was placed in the conduit in such a manner that it extended across the break and 32 ft. farther at each end. Adjacent sections of the pipe were bolted together by means of angle iron flanges, which were riveted to the inside of the pipe. The placing of these flanges inside instead of outside the pipe caused embarrassment later on, as will be described.

The entire length of lap between the concrete and the steel pipe was filled to form a seal. At the ends of the steel pipe bulkheads were laid up, between the pipe and conduit, of brick in bitumen. The remaining portion of the seal was made by concrete deposited around the pipe through holes drilled for that purpose through the top of the conduit. Use was also made of cement in bags, presumably for the outer ends of the lap, and of grout applied by the cement gun. An effort was made to hasten the setting of the concrete by introducing live steam into the conduit and by banking coke fires against the exposed portion of the pipe.

As soon as the seal was completed as described the head gates were opened and it was at once apparent that the repairs made were inadequate. Leaks occurred through the seal and also through the bolted flange joints which were provided with rubber gaskets. Since the bolts were inside the pipe it was necessary to empty the conduit in order to tighten them. Men entered the conduit through a manhole in the exposed portion of the pipe line and tightened up the bolts. The seal between pipe and conduit was also improved, and the new concrete, which was carefully placed, was given 24 hours in which to set before the gates were again opened. This time the repair was a success. Since the head gates were opened on the evening of January 2 the normal supply of water has been delivered through the conduit to the city.

While the municipal conduit was out of service the city was partially supplied with water through connections between the city mains and the mains of the distribution system of the Montreal Water and Power Company. About 30 per cent. of the normal supply was furnished in this manner. Some water was distributed by means of portable tanks on carts.

Safeguarding Heating Pipes

EVEN the comparatively low heat of hot air ducts, steam and hot water pipes is unsafe to trust without special safeguards, says the American Carpenter. It is a generally accepted fact that wood charred very slowly ignites below the temperatures required for ordinary charcoal.

A hot-air pipe can get too hot to touch comfortably: it must always be of metal. It is recommended not to place these inside of wood partitions at points nearer than eight feet from the furnace, to allow six inches between bare woodwork and the pipes, and in partitions or closets to enclose each in a tin pipe at least one inch larger than itself or to protect the nearest wood with a tin shield set out from the wood one and one-half inch from the pipe. Or the pipe can be encased in metal lath, plastered, provided there is seven-eighths of an inch of plaster outside the metal lath. On horizontal pipes, a clearance of three inches between wood and the protecting covering is recommended.

Steam and hot water pipes should be two inches from bare woodwork, or one inch from that with a metal shield, and be centered in a metal tube of one inch larger diameter where passing floors or partitions with a cap at the floor. Indirect radiator boxes or similar casings should be lined. To economize heat, steam and hot water pipes are frequently covered, but it is dangerous to apply a covering which can burn, and some of the trade articles have in the past been found to possess that danger. For economical reasons it is well to select one which is as little subject to disintegration from steam or water leakage as possible.

A register in the floor to heat one room from another below is an opening which directly violates the principle of preventing the upward passage of fire, and is therefore objectionable.

A Substitute for Cement

In Turkey, where cement is not used or hardly known, a substitute has been found that has met with rather good results when applied in exposed places, in filling crevices in water pipes, covering joints in stone floors, in fountains, and for numerous other purposes where cement would be required. The mixture is as satisfactory in water as in exposed places, but it must be allowed to become thoroughly dry before it is submerged. The mixture is slaked lime, linseed oil, and cotton fiber. Generally a hollowed-out stone is used, although a flat, hard surface will answer, and the process is started by pouring the oil on a handful of cotton, after which the lime is dusted in. It is then kneaded until the whole is thoroughly mixed and about the consistency of dough. The more it is kneaded the better it becomes. This compound has undergone a severe endurance test at this consulate. Two years ago the stone floor in the balcony on the north side of the house leaked in several places and rotted the woodwork supporting the balcony. The floor was finally taken up, new timber added, and the stone flags again put down. Between each stone this mixture was forced in and smoothed over the joints. It took several days for hardening, the oil spread out on the stones for about half an inch from each joint, leaving a slight mark, but the compound soon hardened like cement, and to-day the surface over the part where the stones are joined is as hard and smooth and water-tight as if cement had been used.

Economic Conduit Location

Diagram to Assist in Selecting Proper Type of Structure for Varying Topographical Conditions

EVERY conduit carrying water, unless located in a country of uniform topography, changes at certain points from one type of construction to another for the sake of economy and safety. Rarely does a conduit of any great length consist entirely of canal section. It changes to flumes, siphons, pipes, bridge flumes or tunnels as demanded by the prevailing conditions. The points of change are determined not only by the slope of the ground, material encountered and local conditions, but also by economic considerations. In a paper printed in the "Proceedings" of the American Society of Civil Engineers for December, 1913, Mr. C. E. Hickok explains a diagram, evolved by him, giving the equivalent lengths, from an economic standpoint, of various types of conduit.

Tunnel or Open Cut?

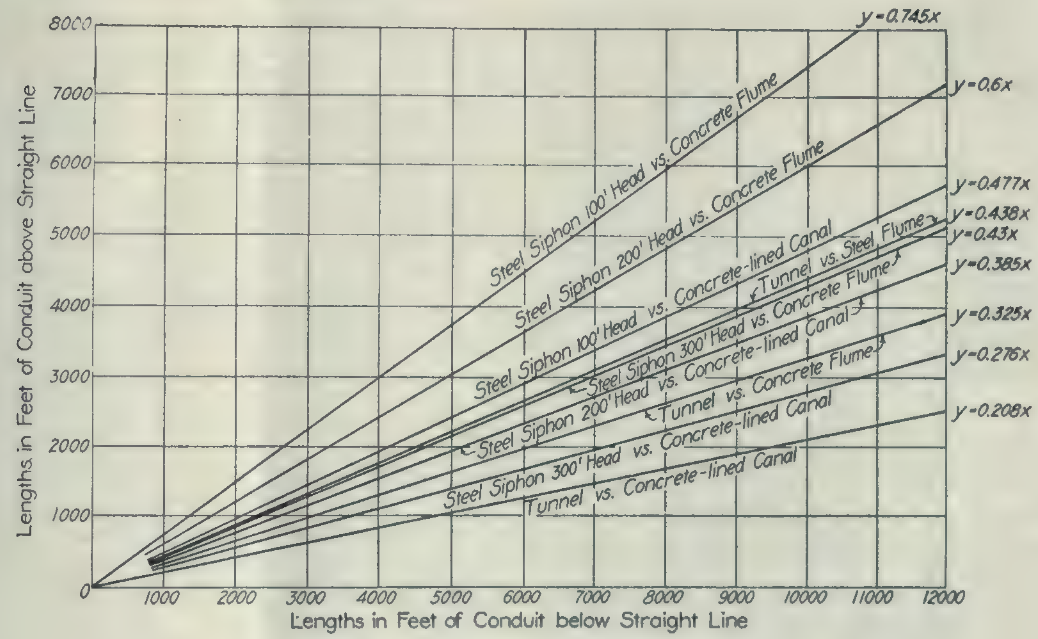
This diagram is so constructed that when a locating engineer comes to a point where he must decide whether to tunnel through a ridge or follow the grade around it with a canal, he measures the length of the two possible routes and decides the question by means of the diagram. This not only eliminates loss of time but assures a comparison between the alternatives as to first cost, depreciation, head and evaporation and seepage loss values, interest, taxes, inspection and repairs.

Assume a case where the project under consideration is to be used for irrigation and hydro-electric purposes, and where the conduit has a capacity of 44.6 sec.-ft. and a slope of 0.1 per cent. Four types of conduit to be used are shown in the accompanying drawing.

Obviously each foot in length of conduit saved means a saving in head loss, as well as in evaporation and seepage losses. The value of this saving is ascertained in the following way, taking 1,000 ft. of conduit:

Head Loss.—A conduit 1,000 ft. long dissipates 1 ft. head. With a discharge of 44.6 sec.-ft. and 77 per cent. efficiency the horse-power value is $(1 \times 44.6 \times 62.5 \times 0.77)/550 = 3.9$ h.p. = 2.8 kw. Subtracting 10 per cent. for transmission and transformer losses, the result is 2.61 kw. at \$55 = \$143.50.

Evaporation Loss.—Assuming an evaporation of 5 ft. per annum $(8 \times 1000 \times 5.0)/43560 = 0.915$ acre-ft.



Equivalent Lengths of Various Conduits

BASED ON ESTIMATED ORIGINAL COST, ANNUAL EXPENSES AND PRODUCING VALUE OF ONE LINEAR FOOT OF CONDUIT

General Formula.— $y(C_y) = x(C_x) + (x - y)V + x(A_x) - y(A_y)$ where C_y = estimated cost per foot of conduit above line; A_y, estimated annual expense per foot of conduit above line capitalized at 10 per cent; C_x, estimated cost per foot of conduit below line; A_x, estimated annual expense per foot of conduit below line capitalized at 10 per cent; and V, estimated value of one foot of canal for power and irrigation purposes = \$2.53. Tunnel is credited with 10 cents per foot for saving in evaporation.

Type of conduit	Values Used Original cost per ft.	 Annual expenses per ft.
Tunnel	\$16.50	\$1.98
Concrete-lined canal	2.30	0.325
Concrete flume	4.28	0.579
48-in. steel siphon, 100-ft. head	5.88	0.961
48-in. steel siphon, 200-ft. head	7.46	1.211
48-in. steel siphon, 300-ft. head	10.64	1.714
Steel flume	5.58	0.887

Steel siphons are credited with \$1.10 per foot for saving in evaporation and seepage.

Example: 4000 ft. of concrete-lined canal can economically be replaced by less than 832 ft. of tunnel.

per year = 0.0025 acre-ft. per 24 hours = 0.00125 sec.-ft. with a head of 1500 ft.; (0.00125 x 1500 x 62.5 x 0.77)/550 = 0.162 h.p. = 0.121 kw. Subtracting 10 per cent. for transmission and transformer losses, the result is 0.109 kw. at $55 = $6.

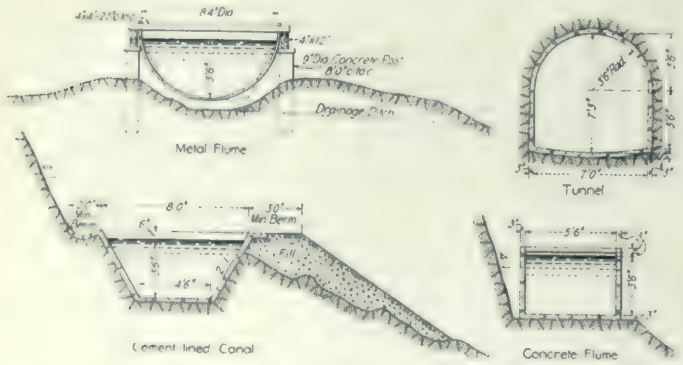
Seepage Loss.—From tests made by Messrs. Elwood Mead and B. A. Etcheverry at the University of California it is concluded that the rate of percolation through a 3-in. canal lining under a head of 3.5 ft. is about 0.0043 ft. per hour, or 0.103 per 24 hours; (8 x 100 x 0.103)/43560 = 0.0188 acre-ft. per 24 hours = 0.0094 sec.-ft., and (0.0094 x 1500 x 62.5 x 0.77)/550 = 1.23 h.p. = 0.92 kw. Subtracting 10 per cent. the result is 0.828 kw. at $55 = $45.54.

The total annual power loss is $143.50 + 6 + 45.54 = $195.04. This amount capitalized at 10 per cent. is $1,950.40, or $1.95 per foot.

Irrigation Losses

The value 0.0025 acre-ft. in 24 hours from the foregoing = 0.00125 sec.-ft. = 0.0625 miner's inch. Assume 25 per cent. evaporation loss before delivery to consumer. Then 0.047 miner's inch at $0.40 per day makes $6.86 per year loss by evaporation.

The value 0.0188 acre-ft. per 24 hours, from the foregoing = 0.0094 sec.-ft. = 0.47 miner's inch. Subtracting 25 per cent. loss gives 0.353 miner's inch, which at $0.40 per day makes $51.64 per year loss by seepage.



Selected types of conduit used for establishing diagram.

The total annual irrigation loss is $6.86 + 51.64 = $58.50. This amount capitalized at 10 per cent. is $585 or $0.585 per foot.

Resume

The power loss per foot is $1.95; irrigation loss per foot, $0.585; total loss per foot, $2.535. The first cost and the annual charges of each type of conduit are next computed. The annual charges are taken as consisting of the following items: Interest, depreciation, taxes, inspection, and repairs. The annual charges of each conduit are capitalized at 10 per cent. and added to its first cost, which gives a figure having a real comparative value. For instance, the comparison between a lined canal and a concrete-lined tunnel is obtained as follows:

For concrete-lined canal the first cost per foot for excavation, 2 cu. yd. at $0.36, is $0.72; for concrete, 4.25 cu. ft. at $10.20 per cubic yard, the cost is $1.57. The total cost is $2.29. The annual charges are: Interest at 10 per cent., $0.23; depreciation at 2 per cent, $0.046; taxes, $0.019; inspection, $0.01; repairs, $0.02; or a total of $0.325. Capitalized at 10 per cent. this makes $3.25, or together with $2.29, the first cost, a total of $5.54.

Concrete-Lined Tunnel

Excavation for concrete-lined tunnel, 2.25 cu. yd. at $5.50, costs $12.40; concrete and forms cost $4.10, or a total of $16.50. The annual charges are: Interest at 10 per cent., $1.65; depreciation, at 1 per cent. $0.165; taxes, $0.137; inspection, $0.01; repairs, $0.02—total, $1.982.

Capitalized at 10 per cent. this makes $19.82, which, together with the first cost, gives a total of $36.32.

It is evident if the conduit is shortened by building the tunnel that the first cost and the capitalized annual cost of the tunnel can exceed the first cost and the capitalized annual cost of the canal by an amount equal to the length of conduit saved multiplied by the loss value per foot of conduit.

In the case of a tunnel, the evaporation will be considerably lessened, thereby effecting an additional saving. If entirely eliminated, this saving would amount to 12.8 cents per foot as shown above. This was reduced to 10 cents and the first cost of tunnel credited with that amount.

In the same way any two types of conduit can be compared and the resulting straight-line equation obtained. The diagram, which is self-explanatory, shows the results.

In the case where a siphon crossing a gulch is compared with a canal or flume passing around the head of the gulch the cost of the siphon is credited with the saving in evaporation and seepage throughout its length, which in this case amounts to $1.10 per foot.

A diagram of this sort cannot be relied on entirely in the location of a conduit, for there are local conditions on every piece of work which must be taken into account.—Engineering Record.

Quebec is the province in which Canada's production of asbestos is obtained. The shipments of asbestos in 1912 were 111,561 tons, valued at $3,117,572, and of asbestic 24,740 tons, valued at $19,707. The shipments in 1911 were 101,393 tons, valued at $2,922,062, and of asbestic 26,021 tons, valued at $21,046. The shipments in 1912 consisted of 5,662 tons of crude asbestos, valued at $890,351, and 105,898 tons of mill stock, valued at $2,227,221. Considerable quantities of crude and mill stock were held in manufacturers' hands at the end of the year, reports Mr. John McLeish, of the Department of Mines. Imports and manufactures of asbestos in 1912 were valued at $461,449 and in 1911 $319,815. Asbestos is an important fireproofing material. Its fibrous structure adapts it to a wide range of applications, from woven fabrics, such as theatre curtains and articles of clothing, to various forms of shingles, stucco, plaster, lumber and other building materials.

No bids for the comprehensive system of passenger subway rapid-transit lines authorized by the city council of Chicago, were received on January 5, when bids were to have been opened. The proposed work covers approximately 57 miles of route, of 135 miles of single track, costing $96,000,000 for subway construction and $34,000,000 for equipment. The nearest approach to a bid was an offer from W. H. Brown Construction Company, of London, offering to bid. Failure to attract bids is attributed to legislative handicaps, since the city cannot grant a franchise to exceed 20 years, and this must include the period of construction, from 3 to 5 years.

Waterproofing and Paint for Cement

Showing the Need for Special Treatment of this Material to Make it Suitable for Building Purposes

By George H. Gresser

THIS problem is of great interest to the engineer, architect, building contractor and owner, as it is only recently that cement and concrete are being used extensively in the construction of the modern building. Statistics show us that in the last fourteen years the production of cement has increased from three million barrels to thirty-five million barrels a year. The cause of this wonderful increase is due to the economy in manufacture and efficiency in concrete construction. But with all the advantages that cement has over other materials as to economy and strength, great care must be exercised in mixing and applying it to the finished surface, to get it uniform in color. Hollow blocks are the worst. It has been proven that they absorb moisture four to five per cent. of their own weight and retain this moisture for some time. Damp walls, as we all know well, are a detriment to health, and this factor is appreciated to such an extent that it has actually retarded the use of concrete in some instances.

Another argument against cement surfaces is that you do not get a uniform, pleasing color, but get varied shades of dull gray, very uninviting, that do not compare with the rich colors we find in terra cotta, granite, brick and decorated wood surfaces. There is no comparison, as cement surfaces, undecorated, give us a dreary, sometimes dirty, color that does not reflect the light, but absorbs it, and does not please the eye or appeal to the artistic temperament.

This little talk is not intended to condemn cement as a building material, but to advocate its use more than ever by improving over what is done in that line today. If we can add to its strength, economy and fireproofing features a decorative rich color, and at the same operation make it moisture and strictly water proof, we certainly will have a building material that cannot be duplicated the world over.

But, you will say that we have it now to a certain degree. Some makers of cement add color while making the cement. Some engineers and architects specify waterproof powder or liquid to be added to the cement while mixing. This has not been proven a success, as anything of that nature added to cement decreases its tensile strength to such an extent that it is almost unsafe. It also affects the metal used for reinforcements. You cannot get the added color on waterproofing compounds mixed uniformly, and still have your different shades, and this very often deteriorates the concrete body and leaves a bad surface for any kind of painting in the future.

The question now arises: "What is the proper way to treat cement surfaces so as to get them decorated and waterproof?" This paper, as you can see, can be made a very lengthy one and requires careful study and research and would take up too much of your time. I am, therefore, going to touch upon the most important points only, and to give you the benefit of my experience along that line.

Washes, brushed on the finished surface of cement, made from waxes, gums, paraffin, etc., have been tried, but without complete success

The first method used with paint was to first give the cement a wash with zinc sulphate and finish over this wash with a white lead and linseed oil paint, but the paint does not hold up and it is now conceded that linseed oil paint is a failure for cement surfaces, as the alkaline salts in the cement attack and disintegrate it.

The last and most successful method and material used today, and conceded by chemists, engineers and concrete men to properly decorate and waterproof cement is a specially prepared paint, in several shades, to be brushed on by competent painters. The material contains no linseed oil or white lead and firmly adheres to the surface, filling small cracks and voids. Such a material is made by different manufacturers under various proprietary names, and requires two or three coats, which can be put on damp surfaces, but should be put on dry surfaces, and does not cover more than two hundred square feet to the gallon one coat. This material gives the dead flat finish of cement, and adds to the cost of your contract between 35 and 40 cents per square yard of surface painted. The smooth or rough surface of the cement finish has all to do with the cost of labor and material, as the stucco and rough cast surface requires more material and more brushing than the smooth troweled surfaces.

Inside Walls and Floors

Up to this point I have touched upon cement surfaces of the outside of buildings only. But we have inside walls and floors which must be decorated and made dampproof, and floors must be made so the cement does not dust off.

Inside cement walls are either in the damp or dry class. Damp walls, especially where there is a water pressure, such as along rivers and walls that get soaked with water after heavy rains, are a problem and should, if possible, be coated on the inside and outside with a paint made from asphaltum products and decorated afterward with regular cement coating. Inside cement walls that appear dry are not such a difficult problem and can be treated the same as ordinary walls.

In connection with the damp class of walls I will say that there are on the market to-day several paints recommended and made to apply on damp walls, but cannot say as to their success when used against water pressure.

Another class of surfaces are cement floors. We all know that when put to heavy wear they soon show defects, get slippery or throw off dust, especially where rich in cement and troweled to a granolithic surface. Giving the floor a cement wash will not answer for factories, shipping rooms or engine rooms. The acids in the lubricating oils attack the cement and destroy its bond. The texture of cement floors and the finish vary so much that we cannot make the same specifications for all of them. They must be tested with specially prepared paint and put on by some one who has made a special study of dampproofing and decorating cement surfaces.

As a business proposition for the general contractor, I think it would be well to investigate this matter, as it is practically a new branch in the building business, and I am sure you can secure more cement contracts when you can say to your customers that you can overcome the unsightly color and non-uniform appearance of our greatest building material.

A recent decision of a magistrate in British Columbia was to the effect that an architect cannot claim a mechanic's lien in connection with the preparation of plans for building purposes.

History of the Montreal Waterworks with an Outline of Present Improvements

THE history of the Montreal waterworks has been compiled by Mr. F. Clifford Smith and submitted to the Mayor of Montreal and members of the Board of Commission. It is published in the form of a booklet which is prefaced by photographs of the officials under whose administration the modern improvements to the waterworks at Montreal have been conducted.

The review starts with the year 1800, when Montreal was a town of about 9,000 inhabitants who lived mainly within the old fortifications, and when the only means provided by the municipality for the supply of water consisted of public pumps at about half-a-dozen points. The selling of water in big puncheons was a common and quaint custom of those days.

Monteal Waterworks—Steam mills and baths in use in 1883.

In 1800, after considerable talk about forming a waterworks, an act was passed incorporating Joseph Frobisher (one of the founders of the Northwest Trading Company) and his associates, under the title of the Company of Proprietors of the Montreal Waterworks. The capital invested was six thousand pounds with power to increase to forty-eight thousand pounds. An exclusive franchise was given for fifty years. The system decided upon was that of gravitation. Water was obtained from a pond in the rear of the present Cote des Neiges village, and was brought to the city through wooden pipes laid around the southern slope of the mountain.

The company's trouble soon began. The supply which was from a well, was most precarious, while the frequent bursting of the wooden pipes finally resulted in the enterprise becoming a failure. In 1816 the waterworks and the unexpired franchise of thirty-five years were offered for sale and sold three years later for £5,000. The purchasers abandoned the gravitation supply from the spring and instituted a steam pumping plant, the engines, of course, being very primitive. The supply was obtained from the St. Lawrence, in the near vicinity of the city. Instead of wooden pipes, four-inch iron pipes were substituted and wooden cisterns erected. The cisterns were found to be very weak and were finally replaced with other wooden cisterns lined with lead. The capacity of the cisterns was 240,000 gallons. The four-inch pipes put down soon proved insufficient and other troubles ensuing, this company also sold out. The plant was advertised for sale and was bought in by a Mr. J. Haynes for sixty thousand dollars. Mr. Haynes quickly floated a new company which replaced the small pipes in the streets by pipes ten inches in diameter and installed a more powerful engine. In 1843 two engines were at work with a pumping capacity of 93,000 gallons. By this time fourteen miles of pipes were laid in the streets.

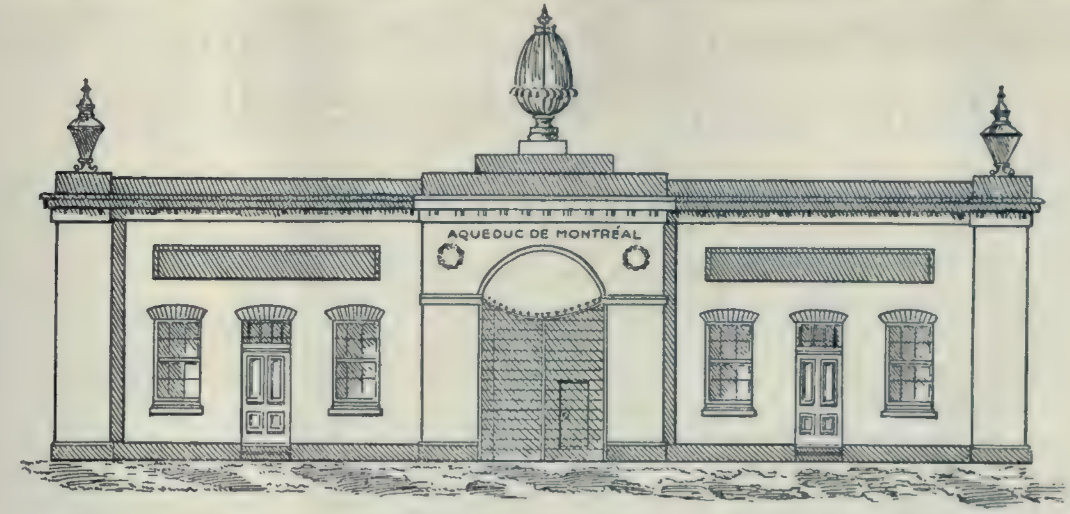
In 1843 also the first agitation was started for the city to own the waterworks. It was kept up till 1845, when the municipality made an offer of fifty thousand pounds for the plant which was accepted.

We reproduce sketches of two of the quaint buildings of early days. One peculiar looking structure shows a combination steam mill and bath as it stood in 1833. The building was four storeys high. Water was pumped from the river near the bank. The three-storey house was occupied in the year 1833 both as a storage for water and as a dwelling. The two upper storeys were altered so that they could contain two large cisterns each containing about one hundred thousand gallons of water. The lower floor was used as a dwelling house. The sketch showing the gateway with the windows and a door on each side, was what was termed the corporation's offices. Over the gates are the words Montreal Water Works. The structure in 1833 stood on Notre Dame street exactly next to the house where the cisterns were. The building has long ago disappeared.

In 1847, two years after the civic authorities of Montreal had taken over the primitive plant, the Water Committee made a report to the City Council suggesting that a premium be offered for the best plan to force water from the St. Lawrence into a reservoir on the mountain. The idea was to get water power from the Lachine Canal. The suggestion was deemed impracticable and not acted upon.

In the year 1849 the city constructed a reservoir on what now is St. Louis Square. Its height was 130

Montreal Waterworks—Storage building of 1883.



Montreal Waterworks—The private company's offices and workshops which stood on Notre Dame Street in 1833.

feet above the St. Lawrence and its cost was three thousand pounds. By the year 1850 the corporation had laid nineteen miles of iron pipe and six miles of lead pipe. The reservoir had a capacity of three million gallons.

In the year 1852, the year of the great fire, when much of the waterworks system was destroyed, the services of Mr. Thos. C. Keefer were procured by the city to draft a plan whereby the city could get an entirely new water supply. The plan he proposed was adopted and it has practically been in operation up to the present, when it is being drastically changed. The system consisted in an open canal having the entrance about a mile and a half above the Lachine Rapids. The canal or aqueduct, which was 4¾ miles long, ended at a building called the Wheel House. This building contained two vertical hydraulic wheels operating a set of six pumps having a capacity of four million gallons a day. The water was raised through a main of twenty-four inch diameter, and ended at a reservoir where the present McTavish reservoir stands. The construction of these works lasted until 1856 and cost $280,237.

Further interesting details of the various improvements effected under civic control are given by Mr. F. Clifford Smith, but with the limited space available we must pass on rapidly.

We learn that the first steam engine was installed in 1868, by which time the consumption had passed the mark of five million gallons a day. Extensive improvements were made in the "70's" under Mr. Louis Lesage, superintendent of the water department. We are told that the work was greatly hampered by constant change in the membership of the city council, lack of funds and various other causes—no less familiar to-day than forty years ago.

Scheme of Present Improvements Outlined

Extensive improvements have been recommended by the present city engineer, Mr. Geo. Janin, after an investigation of some years.

The successful tenders for the improvements, and the dates the contracts were awarded by the city are as follows:

Lateral Conduit:—Contract awarded September 6th, 1907, to P. McGovern.

Intake:—Contract awarded September 27th, 1910, to Lemoine Fils & L. A. Desy.

Filtration Plant:—Contract No. 1, awarded July 17th, 1911, to the "British Electric Plant Co.," for the supplying and installing pumping machinery, blower and crane.

Contract No. 2, awarded July 24th, 1911, to F. H. McGuigan, for constructing final filters and appurtenances.

Contract No. 3, awarded October 9th, 1911, to F. H. McGuigan, for constructing prefilters and filtered water reservoir.

Contract No. 4, for final deepening and widening of aqueduct, awarded July 5, 1913, to the Cook Construction Company.

On October 1st, 1912, a transfer was made of the works of Mr. McGuigan to Mr. Norman McLeod.

Final Estimated Cost of Present Improvements When All Completed

Lateral conduit ..	$ 785,000	(Work done)
Intake	124,000	do do
Widening of Aqueduct:—		
Contract No. 1..	856,000	(Work done)
Surveying and Supt's.	80,000	do do
Contract No. 2..	2,970,000	(Estimated cost)
Engr. and super..	80,000	do do
Pumps and power house	425,000	do do
Filtration Plant:—		
Contract No. 1..	40,000	(Work under contract)
Contract No. 2..	673,000	do do do
Contract No. 3..	485,000	do do do
Contract No. 4..	400,000	(Estimated cost)
Engr. and super..	80,000	

When to the above is added the probable cost of purchasing of land for the aqueduct, the entire completion of the system is estimated at seven million dollars.

When all of the above work is done the total value of the waterworks of Montreal is estimated at $19,000,000. In this sum there are included, of course, all kinds of mains and pipes in the streets.

Sanitary Survey of Boundary Waters between Canada and the United States

FOLLOWING is an abstract of the report submitted recently to the International Joint Commission by the board of sanitary experts appointed to make an investigation of the pollution of the boundary waters between the United States and Canada. This is the first portion of the report, dealing with the extent and causes of pollution. Preventive measures will be discussed in a later document. The Canadians engaged in the technical side of the work are Dr. W. S. McCullough, Provincial Health Officer for Ontario, Dr. John Amyot, Professor of Hygiene in the University of Toronto, and Mr. F. A. Dallyn, Provincial Sanitary Engineer of Ontario. It may be as well to point out that the investigation began at Lake of the Woods in Ontario and terminated at Grand Falls, on the St. John river, between New Brunswick and Maine.

The number of sampling points was 1,447 and the total number of samples collected, 17,784. Many other samples were taken to show the relation between local situations and municipal water supplies, and to ascertain the character and amount of pollution due to boat traffic. Some float and temperature experiments were made in conjunction with the bacteriological investigation.

Bacterial Examination

The examination was essentially a bacteriological one. Five classes of water were arbitrarily defined, as indicated in the table.

Class 1 represents those relatively pure waters found outside the zones of pollution. Class 2 represents a slight pollution of a relatively pure water. At times such a water is undoubtedly unsafe without purification. Class 3 represents considerable pollution, requiring unremitting care in its purification. Class 4 shows serious pollution. In the Great Lakes Basin such a water should not be selected as a raw water for a purification plant; or, if the intake must be placed in such water, sources of pollution should be eliminated or nullified by sewage treatment. Class 5 represents gross pollution—from 50 to 34,000 B. coli per 100 cu. cm.

The maximum bacterial count was used as the index of intermittency of pollution, which is the great menace to water supplies. At the time of inspection extreme runoff due to floods was not encountered. Every municipality in the area investigated on the Great Lakes discharges its sewage untreated into the lakes, constituting the largest factor in their pollution. The bulk of the work was done on the connecting rivers and the ends of the lakes.

Rainy Lake, Ontario

Samples examined in Rainy Lake show unusual pollution, probably on account of the presence of construction camps and lumber mills. In general the Rainy River shows serious pollution throughout its length, but in an increased degree below Fort Frances and International Falls to the Lake of the Woods, making this whole river an unsafe source of water supply without very careful purification.

The examination of the waters of Thunder Bay showed that the pollution found there did not reach the international boundary, some 35 miles distant. The local situation is, however, an unfortunate one. The general tendency is to spread sewage polluted water along the shores rather than out into the bay. The bulk of the water of Lake Superior is pure, about the only possible source of pollution being from the vessels plying upon it.

Lake Huron

The examination of samples in the lower end of Lake Huron showed that this water would be practically pure were it not for the pollution due to boat traffic. That portion within a radius of three miles from Point Edward Light showed a slight though definite pollution. The sample points near the shore on both Canadian and United States sides gave an average of 15 B. coli per 100 cu. cm. The slight general pollution within this portion of Lake Huron, while due in part to the large summer population and seasonal effect of streams, must be accounted for chiefly by the enormous boat traffic through the middle of this area.

The water of the River St. Clair from its head to Lake St. Clair is unsafe as a source of water supply without careful and unremitting purification. The several cross-sections from St. Clair to Algonac show gross pollution of the river, more marked on the United States than on the Canadian side, owing to the fact that the discharge of sewage is chiefly from the United States side, the Canadian municipalities below Sarnia not being sewered.

The bulk of the eastern portion of Lake St. Clair was shown to be comparatively pure.

Detroit River

The cross-section where the Detroit River leaves Lake St. Clair showed about the same degree of pollution as the lake in the centre of the channel, with increased pollution close to the United States shore. Belle Isle had considerable pollution at the head near both shores. This is enormously increased at the next cross-section, especially at the sample points near the United States shore. The stream above the intake for the Detroit city water supply was found to be an unsafe water supply without careful treatment. The application of hypochlorite of lime in the quantities or by the method in vogue in Detroit during the investigation is not considered adequate treatment. The several cross-sections from this point to the site of Michigan Central Tunnel showed a marked increase of pollution in the shore samples. The water intakes of Walkerville and Windsor, Ont., are both located in dangerous situations, owing to the discharge of sewage above these intakes and to the pollution due to navigation. Gross pollution over the Michigan Central Railroad Tunnel near the Canadian and United States shores, and a considerable pollution extending across the entire river were found.

The B. coli content per 100 cu. cm. has increased in Lake St. Clair water from below 5 to an average of 315 at the head of Fighting Island. Fighting Island divides the river into two channels. There is a great difference in the degree of pollution in these two channels. In the channel between the United States shore and Fighting Island the pollution is enormous.

An extensive investigation was made of the area at the mouth of the Detroit River and western end of Lake Erie to Put-in-Bay. The examination indicates the existence of such gross pollution that the water in this part of the lake is unquestionably a very dangerous one, especially to crews and passengers of vessels using water pumped from the region.

There is no point from the lower end of Lake Huron to the islands which separate the western end from the remainder of Lake Erie from which a safe supply of water could be taken for even a portion of the 365 days in a year.

At Port Stanley the evidence indicates that Lake Erie is pure and such pollution as is picked up in the neighborhood of any local source of pollution is confined to that district.

Samples collected at the eastern end of Lake Erie along a line from Point Abino to the United States shore about 12 miles above Buffalo show the water in the eastern end of the lake to be pure, except as it may be influenced by the effect of navigation. Pollution from Buffalo and other sources extended but a short distance beyond the breakwaters, and the water from that point almost to the Canadian shore across the boundary is relatively pure, except as directly influenced by navigation.

Dilution of Sewage in Niagara River

The first cross-section of the Upper Niagara River showed relatively pure water on the Canadian side and the beginning of noticeable pollution from Buffalo harbor. From the next cross-section to the one below Squaw Island the pollution, though greatly increased in quantity on the United States side, was held to that shore. The pollution on the Canadian side, though of less extent, was likewise confined to its shore. This phenomenon is due to the immense volume and the great velocity of the river, and to the depth of the outlets of the Buffalo sewers. From this point the pollution tended to extend across the entire Tonawanda Channel, and from Rattlesnake Island to the point where it again joins the main river the whole channel was shown to be grossly polluted. The use of this water as a public supply, even with the stringent purification, is attended with considerable risk.

The Niagara River at Lewiston receives the water from the Great Gorge Rapids and the Niagara Falls. The mixing of the sewage affected by the falls and rapids with the river water is probably the most complete possible. The samples examined showed that from this point to the mouth of the river the water was uniformly polluted from shore to shore and that the use of water from this section of the river as a public water supply without the most careful and exacting purification should not be considered.

The situation at the mouth of the Niagara River is different from that of any other of the waters under investigation. At the mouth of the Detroit River the discharge is into an inclosed end of the lake, where it is lagooned and drifted from point to point for a considerable time before it can get into the lake itself. At Niagara, the pollution is discharged into a portion of the lake where conditions are such that the drift may take place north, east or west. Several limits of this polluted area were determined with a considerable degree of accuracy. A striking phenomenon exhibited over this area was that very little diminution in pollution occurred until the limiting boundaries of the area were reached. That is, if at the mouth of the river pollution was such as would show 1000 B. coli per 100 cu. cm., the pollution 10 miles from shore, wind conditions being favorable, would show practically the same degree of pollution. The menace in this area is almost entirely directed at the present time toward navigation between Buffalo and Toronto.

Influence of Summer Residents on the St. Lawrence River

The work on lower Lake Ontario and on the St. Lawrence River was performed at two different seasons by different laboratories. In the season before navigation commenced Lake Ontario water was practically sterile; in August there was minor pollution in the lake. The difference in the findings emphasizes the effect of boat traffic and summer residence pollution.

Below Brockville the major pollution remains near the banks of the river. Mid-stream samples showed very little pollution in the early work before navigation. The later work in August showed a very general serious pollution, due probably to summer resort population on the river and to boat traffic. The conditions from here on to Cornwall are very bad in the summer months. Unquestionably the water at Brockville and from there on should not be used as a water supply without adequate purification.

The St. John River forms the international boundary between Canada and the United States for about 70 miles of its course. The direct sewage pollution from Edmundston to Grand Falls is at present slight. There are seven potato starch factories which have some effect upon pollution.

An average for this portion of the river at this season might be tentatively expressed as follows: Average number of B. coli per 100 cu. cm., 125; average number bacteria per cubic centimeter on agar at 37 deg. C., 250.

A remarkable relation between potato starch factories and increase in B. coli was found. The character of pollution from starch factories resembles that of so-called rural pollution, the washings of manured fields, and is largely of animal origin. While it is not so dangerous as city sewage in the transmission of typhoid fever, it is nevertheless a dangerous addition in drinking water. The amount of pollution contributed is of the greatest importance because it has a direct bearing on the distance required for the stream to purify this addition to its burden of pollution and reach what may be considered its normal condition.

The total amount of pollution contributed at any of the points mentioned is relatively small, and within a short distance the number of B. coli per 100 cu. cm. drops to what may be considered the average pollution of the river. In this large stream, with the relatively small amount of pollution after mixture has been effected, marked improvement is manifest within a few miles. For instance, from the point of maximum pollution about 4 miles below Van Buren, a marked improvement is evident within 4 miles, the average number of B. coli per 100 cu. cm. dropping from 725 to 57.

Conclusions

In certain localities on the Great Lakes and in all their connecting waterways dangerous sewage pollution was shown to exist, but the great bulk of the Great Lakes water remains in its pristine purity.

The colon bacillus is practically never normally present in unpolluted waters, and the normal total bacterial count of the Great Lakes waters is below 10 per cubic centimeter on nutrient agar. This is clearly shown by the results of examination of samples collected in Thunder Bay, in Whitefish Bay, in Lake Huron, in Lake St. Clair, in Lake Erie at Abino Point section, and in cross-sections of Lake Ontario at both ends.

The boundaries of the zone of pollution along the shores or at the mouths of rivers were constantly

1914 28(6)

changing, due to the currents which are themselves dependent upon the direction and velocity of the wind. In two situations, namely, at the mouths of the Detroit and Niagara Rivers, serious pollution extends normally over 10 miles into the lake receiving the discharge. At times it may travel much farther. It was shown to travel in Lake Ontario on occasion 16 miles, and in Lake Erie, 18 miles.

The position of intake and the pollution existing in the vicinity of municipal water supplies are such that there is not a municipality using lake water which can be said to possess a safe water supply without treatment. In spite of these facts until very recently the use of untreated water was the rule. The conditions responsible for the disgraceful record of water-borne typhoid in these cities are: Unrestricted discharge of sewage by municipalities and vessels; failure to purify polluted water, and inefficiency in the purification. In certain localities the pollution is so great as to impose an unreasonable burden upon any known method of water purification, and where intakes are located in such localities some method of eliminating or reducing the pollution, whether from boats or municipalities, is absolutely necessary. It is difficult for some officials to understand, without a severe lesson, that it is not sufficient to have a water supply that is safe for 360 or 361 days in the year. There was no evidence of serious pollution of the water supply of the city of Erie from 1909 to December, 1910, yet the appalling experience of January and February, 1911, showed that pollution could take place under certain weather conditions.

Untreated water supplies are in many instances delivered to the consumer as safe. No water should be classed as safe and furnished as such which is not shown to be safe by daily bacteriologic examination. Opinions based upon a few widely scattered bacteriologic examinations of samples of municipal water supplies collected at random have really very little value even though the tests appear to indicate good water. The public is apt to base its opinion of a water supply upon such tests. This is a dangerous error. Any report upon a water supply is incomplete without a comprehensive sanitary survey. The possibility of a serious pollution even as an exceptional occurrence would be disclosed by this survey.

Information collected during this investigation shows that for lack of bacteriologic control satisfactory efficiency is not being obtained by the purification methods adopted by many of the municipalities attempting to protect themselves against the consequences of polluted water supplies.

A concrete bridge which is being built at the head of Colorado street, Pasadena, Cal., is the longest and highest bridge in the south-west. The roadway, 28 ft. wide between kerbs, is 160 ft. above the channel of the Arroyo Seco, a stream flowing beneath the finest residential section of the city, and the length of the structure is 1,468 ft. The most striking feature of the bridge apart from its long sweeping curve is the series of noble arches, the largest of which is 223 ft. from centre to centre of the piers, while there are two spans of 151 ft. and six of 113 ft. each. The arch spans consist of two continuous elastic arch ribs carrying spandril columns and in part spandril walls. These support cross beams with cantilevered ends. The massive piers rest upon the boulders and gravel of the stream bed and are tested to 11,000 lb. per square foot. Work has been in progress for more than a year, and a few weeks will see the completion of this important link in the California highway system. From forty to one hundred men have been constantly employed. Cement to the extent of more than 10,000 barrels was required for the concrete, which is reinforced with corrugated bars of a strength of from 60,000 lb. to 70,000 lb.

A Plea for City Planning Organization

THE object and scope of city planning and the manner in which legislation can be secured in Canada to attain the ends desired by those interested in this important study were considered in an interesting address given before the Fifth Annual Meeting of the Commission of Conservation by Mr. G. Frank Beer, President of the Toronto Housing Company. Mr. Beer divided his subject roughly into three sections—Sanitation, Transportation and Co-ordination, the requirements which are detailed in the summary abstracted below:

Sanitation

(a) An adequate supply of pure water.

(b) Sanitary and economical disposal of sewage and garbage.

(c) The prevention of slums and provision for the satisfactory housing of wage earners.

Transportation

(a) The arrangement of transportation systems including radials, and the location of passenger stations and freight sheds.

(b) The development of harbour facilities, including the erection of necessary wharves, bridges and docks.

(c) The laying out of thoroughfares to accommodate the necessarily varied traffic.

Co-ordination

(a) The laying out of desirable manufacturing districts and provision for adequate shipping facilities.

(b) The planning of residential districts, especially for working men, so that they may be housed within reasonable distance of their work.

(c) The location of municipal produce markets in proper relation to residential districts and shipping facilities.

(d) The systematic selection of recreational facilities such as parks, play-grounds and swimming baths.

(e) The location of educational institutes such as schools, colleges and public libraries.

(f) The proper distribution of public service buildings, such as fire halls, police stations, post-offices and hospitals.

(g) The acquiring of natural beauty spots and their development as public squares and breathing spaces.

(h) The acquiring of land needed for the purposes enumerated under the five last paragraphs, before an enhanced value places unnecessary burdens upon the public exchequer.

(i) Provision and planning for car-lines, sewage, gas and water-mains, telephone and electric light wires to secure the greatest possible economy in their installation, and to avoid the usual waste of repeated tearing up of pavements and consequent dislocation of traffic.

(j) The laying out of the surrounding territory so that the natural and inevitable growth of the city may be rationally and economically guided.

The list is a long one but nothing included is superfluous. To summarize, **efficiency, economy and vision** in city planning are what are aimed at.

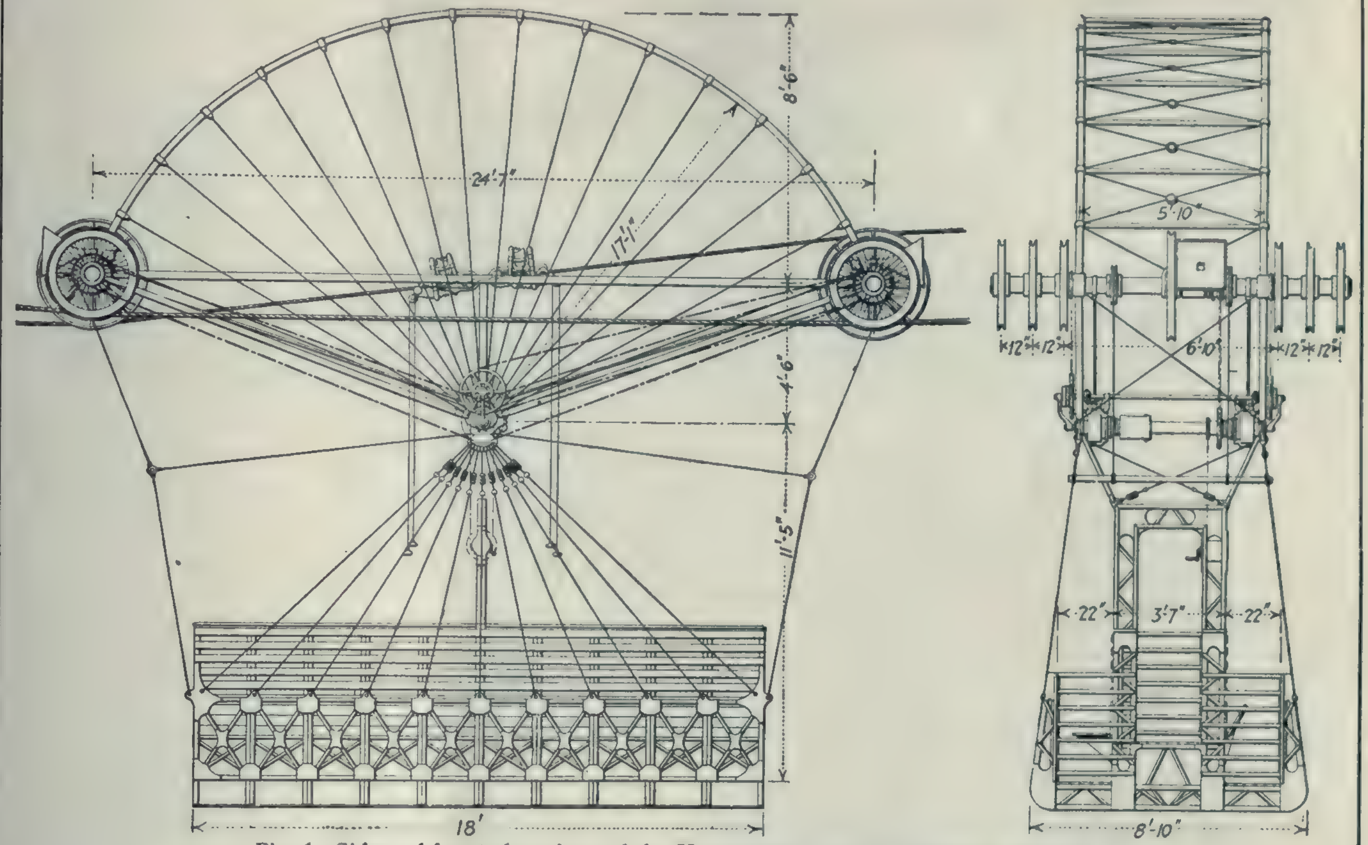


Fig. 1—Side and front elevations of the 50-passenger car for whirlpool cableway.

Proposed Aerial Passenger Cableway across the Whirlpool below Niagara Falls

CONCESSIONS were granted to a Spanish company by the Dominion Government, on November 17, 1913, for the construction of a passenger aerial cableway over the Whirlpool, situated approximately six miles below Niagara Falls, Ontario. The design and scheme of operation of the cableway will be similar to that of the system which connects the two mountain resorts on Mt. Ulia, near San Sebastian in Spain, and similar in purpose to the much bolder project which climbs the first stage (a rise of 1,370 ft. in a horizontal distance of 1,191 ft.) of the Wetterhorn ascent, in the Berner Oberland, Switzerland.

The Whirlpool system will be constructed on a somewhat larger scale than that of Mt. Ulia. The car on the latter had capacity for but 14 passengers while the former can transport 50 passengers at a load. The termini of the line are about 1,770 ft. apart and are at the same elevation—about 250 ft. above the Whirlpool. The car has been built in Bilbao, Spain, and is there at the present time. It is believed that the actual construction work in Canada will commence in March, 1914. The cost is estimated at $120,000.

The system in general will consist of one car drawn back and forth across the Whirlpool, travelling on six 1¼-in. cables and hauled by another. A set consisting of three cables is placed on each side of the car. Should one cable break, the car would be carried by the other five. As a further safeguard in the event of a cable parting, all the cables are outside of the car.

Each cable will be attached separately to a fixed anchorage at one station and at the other station pass

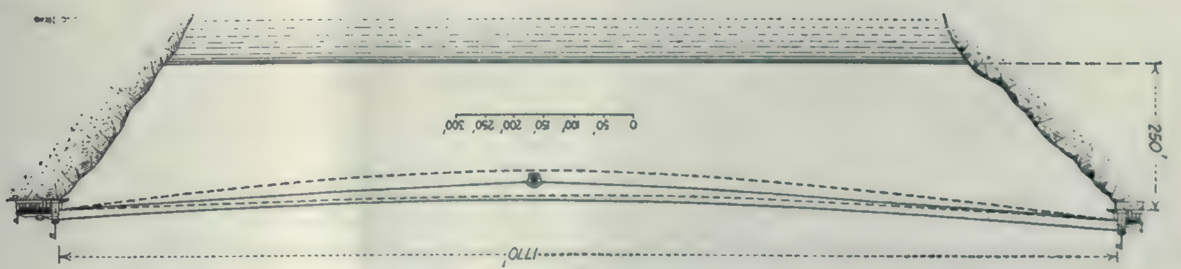
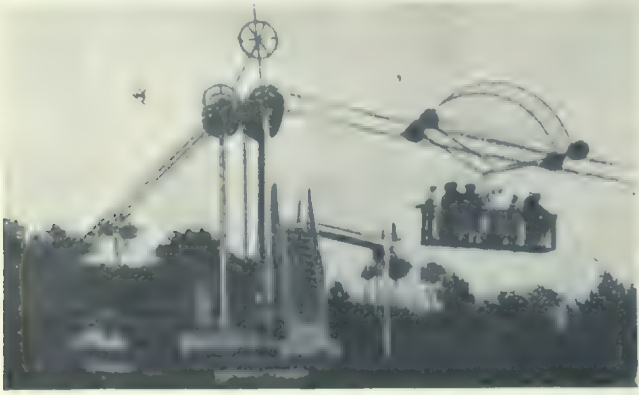


Fig. 2—Elevation of the whirlpool cableway, showing the deflection of the cable due to live-load.

around a sheave to a counter weight. As the cableway is balanced by the counterweights, the weight of the car does not increase the tension in the cables, although an increased car weight (due to passengers) will of course increase the deflection of the cables. The counterweights are designed to prevent a stress in the cables which exceeds one-third their tensile strength. An endless cable, counterweighted at one end and driven by a motor at the other station, hauls the car.

The side and front elevations of the car are shown in Fig. 1; its dimensions are 18 x 8.8 ft. in plan. The car is carried on 12 metal-spoke sheave wheels (six per axle). On each axle also, there is a tractor wheel along which runs the hauling cable. The drawing shows that the body of the car is suspended by means of a system of wires, in tension, which radiate from a curved frame whose upper and lower members are of metal tubing.

Swinging is prevented by wires which connect the car body to the two upper and one lower axles. The supporting wires from the lower axle are each provided with a turnbuckle for regulating its tension. The direction of travel is determined by means of a controller, acting through sprocket chains to single-direction jaw clutches upon either axle. Brakes are installed; and, in the event of the car being stalled, a safety car will be provided for running out on the line. Fig. 2 is an elevation of the system and shows the deflection of the cables due to the car, empty and loaded respectively.



A terminus of the passenger cableway at Mt. Ulia, Spain.

Fig. 3 is a view of the similar system of Mt. Ulia in Spain. It shows the cable connections at one of the termini. The counterweight of the hauling cable is visible; while the six carrying cables are seen, stretching at an angle of about 45 degrees from the pulleys to the concrete anchorage.

The designer of the system is Leonardo Torres y Quervedo, Chief Government Engineer of bridges and roads, Bilbao, Spain. The company which propose to do the work is the Estudias y Obres de Inginierio, of Bilbao, and its president is Victor Gorbena, Chief Engineer of the port.

Latest reports state that the engineers who will have charge of the erection work in connection with the Whirlpool cableway are about to embark from Spain for New York and that work will start on scheduled time.—Engineering News.

One of the largest subway schemes ever planned is said to be in contemplation by a British-Canadian firm of engineers and contractors who purpose organizing a company with $25,000,000 capital to build and operate a comprehensive system of subways for Chicago.

An Interesting Industrial Undertaking in Quebec

The Grand Pabos Mills now being built for the St. Lawrence Pulp & Lumber Corporation by the Aberthaw Construction Company

On a bay reaching back from the Gulf of St. Lawrence, near Chandler, Que., a large pulp mill is being erected for the St. Lawrence Pulp & Lumber Corporation, by the Aberthaw Construction Company, Boston, Mass. The buildings are for the most part of one-storey, located on the slope of a hill so that in some cases they go up in steps, so to speak, and give the appearance of much greater volume than they really possess. The entire plant now under construction, occupies a length of about 900 ft. east and west, with a width of some 700 ft. in the other direction. There are nearly twenty buildings in the present plans, with arrangements for a further extension of several of them as needs of the future may require.

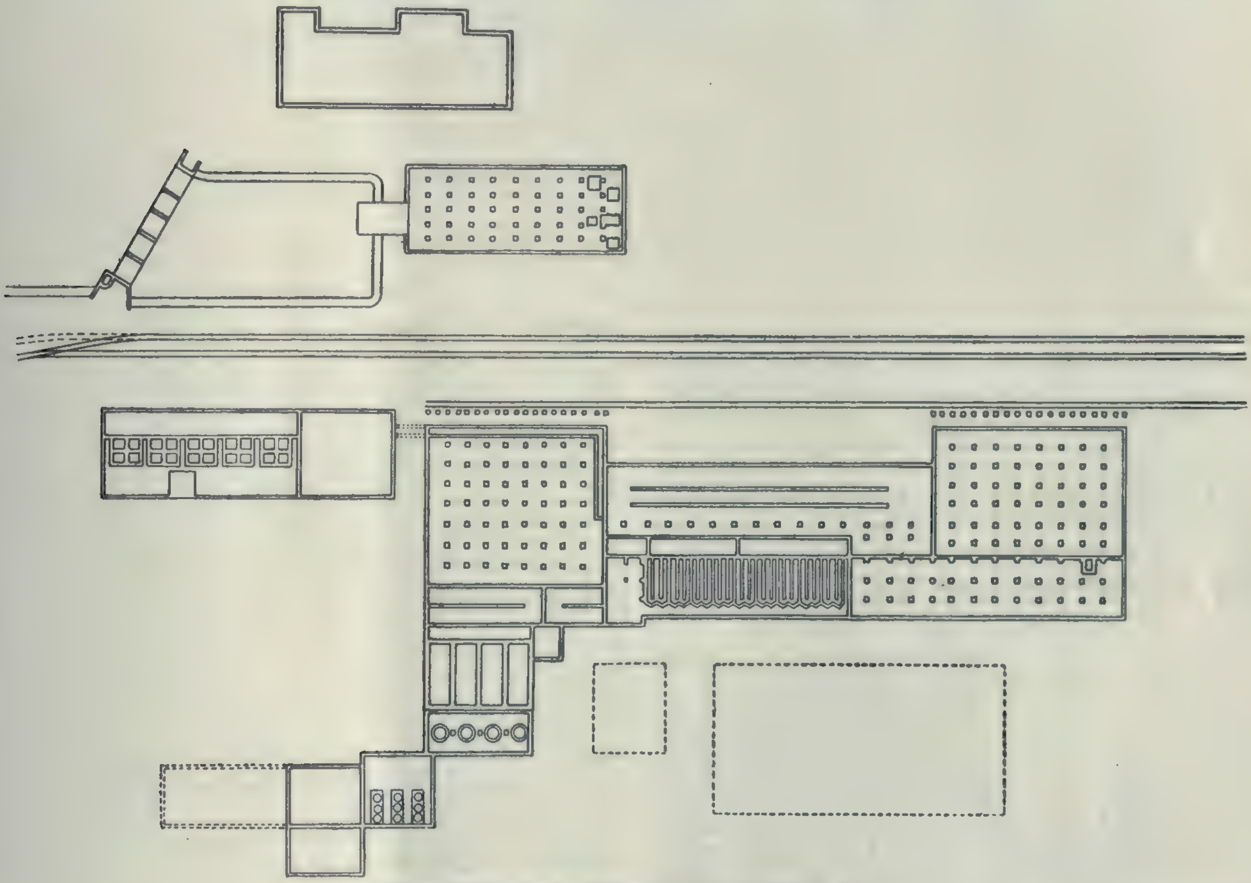
Starting at the west end of the lay-out, a pulp storage building, measuring 78 by 162 ft., has a platform upon a railroad siding alongside the double track road. North of this is a large structure, 78 by 231 ft., of which the north-west corner is occupied by the offices, while the balance is supplies and repair shop. This building continues as the bleacher room, 200 ft. long by 78 ft. wide, and containing nine large concrete bleacher tubs. South of the bleacher room, and adjacent to the pulp storage building is the machine room, 49 by 269 ft. East of the bleacher room and machine room is the screen room divided into two parts, the room as a whole being 150 by 156 ft., with coarse screens in the southerly section and fine screens to the north. Directly north of the screen room are the four blow pits, the space occupied being 67½ by 81 ft. Each blow pit measures 18 ft. 6 in. by 52 ft. and has a depth of 16 ft. 8 in. at one end and 15 ft. 2 in. at the other.

North of the blow pits is the digester house, 35 by 81 ft., containing four digesters 16 ft. in diameter by 54 ft. 6 in. high. These are fed from a conveyor in the monitor on top of the building. The height of this building is 115 ft. Practically all of the others are single storey only. North of the digester house is the acid plant, 57 by 58½ ft., adjoining which are the Pyrites burners in a building 50 by 165 ft., and the sulphur storage building 40 by 64 ft. All of the buildings so far mentioned are continuous without any breaks.

North of the supply and repair building and the bleacher room, is to be an electrolytic plant at some time in the future, which will measure about 80 by 250 ft. Between the electrolytic plant and blow pits and digester house is the filter house, 60 by 73 ft., with provision for expansion northward as may be necessary. In the extreme north-west corner of the property is a 30,000 gallon tank, mainly for fire protection purposes, and with its bottom at an elevation of 180 ft. above the bay. (Most of the mill is at an elevation of about 50 ft.)

East of the main group of buildings is the power plant, consisting of a turbine room 72 by 78 ft., and a boiler room 72 by 164½ ft. There is provision for future extension of the boiler room to about double its present capacity. The present room will contain eight 475 B.h.p. boilers with space for two more later. This room is quite near an arm of the Bay and condensing water is drawn in through a pipe running under the

Panorma of St. Lawrence Pulp and Lumber Corporation's new plant. Foundations for wood room in left foreground. Excavation for hot pond in the lower right.



Ceneral layout of buildings at Grand Pabos, Que.

Bleacher room foundations, looking between pulp storage and supply shop buildings.

Under the floor of the repair and supply shops at the Grand Pabos plant.

St. Lawrence Pulp & Lumber Corporation's new plant at Grand Pabos, Que. Pulp storage building in foreground. Office, and repair and supply shops in rear.

railroad tracks and out to a crib a short distance from shore. After being used, this water, which has been heated by the condensing steam, is discharged into the hot pond, measuring about 90 by 160 ft., and located just south of the railroad tracks adjacent to the turbine and boiler rooms.

This pond is separated from the Bay by a bulkhead so that during the winter time logs in it can be handled without fear of their being frozen up, the temperature being kept up by the hot water from the condensers. There are three separate log hauls or conveyors, from the hot pond, going respectively to the wood room and the sawmill, while one, directly from the Bay, goes to the sawmill. The wood room measures 72 by 182 ft. and is located just west of the hot pond. South of the hot pond and wood mill is the sawmill, 64 by 193 ft., with two or three similar wings, and adjacent to this, another boiler house, 46 by 62½ ft.

The whole plant is laid out for the most economical handling of materials, from the logs in the water or on board schooners, to the finished pulp. The Government of Canada is arranging for dredging the harbor so that vessels of 6,000 tons may safely enter at all stages of the tide. In this way, both the receipt of raw materials and their shipment by water is facilitated, while the railroad connections provide for similar handling by rail. The company controls some 500 square miles of territory from which pulp wood will be cut, so that apparently there is nothing to hinder the full development of this plant as business conditions render it necessary.

Mr. H. S. Ferguson, of New York, is the engineer.

Pneumatic methods for finding flaws in rock indicate whether or not the rock is pervious, but they do not locate the seams. An elaboration of this method is to attach rubber washers to a mouthpiece and by means of them close off a small part of the hole and thus locate possible seams. This procedure, however, is tedious and a method used near Augusta, Ga., for the investigation of the foundation for the dam of a hydro-electric project is claimed to be more economical. Here test holes were drilled into the granite—which was the prevailing rock formation—and dye forced into the holes. In subsequent core-borings the color showed where flaws existed. The method proved satisfactory in that the character of the ledge was known in advance, and thus obviated unnecessary drilling and excavation.

On Flats

THOSE of our readers who dwell in "flats" or apartment houses in the larger cities of the country cannot fail to appreciate the following abstract of an essay on flats by George Fitch and copyrighted by George M. Adams:

"Flats are an invention whereby people who live in crowded cities can be piled up in layers like pancakes.

"A flat consists of a collection of living rooms all on one floor. A flat building consists of from six to sixty sets of rooms all under one roof and under the overlordship of a janitor who lives in the basement and doses the furnace with coal on the homeopathic plan. A really expert janitor can run a twelve-flat furnace all winter on a wagon load of coal and can so chill the tenants when they come down to complain that their rooms will seem tropical when they return to them.

"Flats are built of brick, wood, stone, strawboard, felt and tissue paper, the latter being used principally for partitions. An economically built flat building is usually provided with a lightwell which is entirely filled with conversation. By means of this well the occupant of the top flat can hear what the husband of the first floor says when the coffee doesn't suit him, and when the woman in number 2 tells her late returning spouse that he is a brute the women in numbers 1, 3, 4, 5, 6, 7, and 8 quiver with simultaneous indignation.

"Flats have handsome hallways fitted with New Jersey Turkish rugs, and back porches where one may have a garden consisting of a geranium. They are also provided with bathtubs and two kinds of water, cold and not so cold. In the cities, owing to the high price of ground, aldermen and building material, the rooms in a flat are sometimes very small—so small that when the daughter is playing the piano the mother has to wash the dishes gently for fear of splashing on the music—so small that the members of the family have to be measured for the bedrooms as they would for vests, and anyone weighing over 180 pounds has to work himself into the bathroom by means of glove powder and a shoehorn."

Montreal Builders' Exchange Reports Highly Successful Year

FROM one point of view 1913 was the most successful year in the history of the Montreal Builders' Exchange. It had the largest revenue, $13,598, on record, while the membership fees collected, $3,868, were also the highest recorded. The annual meeting, held on January 26, was presided over by Mr. J. Brunet, who in his address, reviewed the financial position and also the events of the year. He referred to the fact that the permanent exhibition of builders 'supplies established in the Eastern Townships Bank Building had not proved successful from a financial point of view. The revenue from the exhibit hall and offices in 1913 was $1,784.77 less than in 1912 and if the Exchange were fortunate enough to collect the $432.99 still in arrears, they would yet be $1,351.78 behind in this account. The report showed that the decline in interest and support in this department had been steady since 1910. As it was necessary to leave their present premises by May 1st, the outgoing board had been able to secure for the next three years a floor in the Victoria Building, on Victoria Square. The exhibit feature would be done away with; but, at the request of the present sub-tenants and others who desired to have desk room with the Exchange, they would provide for an amount of space to be devoted to that purpose. The policy of the Exchange in the past, like some others, had been to nurse the cause it stood for and the people it existed to help. The results had been unsatisfactory, both to the Board and to the Secretary. The time had arrived when a new policy should be adopted. At the last meeting, after reviewing the situation carefully from all sides, the Board decided to have the regulations of the Exchange carried out rigidly; and where the by-laws were not in accordance with their views they must be amended to meet the conditions. Only men in good financial standing, able and willing to pay their way both in business and in relation to the Exchange, could be members and receive the full benefits of the organization. Those in arrears for membership dues at present must be notified, and if arrears were not paid up within a limited time the names must be "posted" in the Exchange in accordance with the by-laws. Those more than one year in arrears were to be suspended. The members of the present board had expressed the determination to raise the standard and status of membership in the organization to the highest point, so that, as originally intended, it should mean something to hold a membership card in the Exchange. The hearty approval and co-operation of the entire membership was counted upon in this matter both morally and financially.

The report of Mr. R. L. Werry, the secretary-treasurer, stated that there was a deficit of $1,000, but as $2,000 were in arrears and $4,000 were due as fees, there were plenty of assets to offset this deficit. The revenue for the year was $1,000 higher than in any previous period and was $1,600 ahead of 1912.

It was decided to wipe out the deficit of $1,000 by a subscription among the members; also to forego the annual banquet. The members acquiesced in the abandonment of the exhibition, and approved the idea of removing the offices.

The following are the officers for the present year: President, Mr. Thomas Gilday, of Campbell, Gilday Company, Limited; first vice-president, Mr. Frank Pauze, of U. Pauze & Fils Company; second vice-president, Mr. Ernest W. Sayer, of the Sayer Electric; directors, Messrs. John Allan, Ernest Richardson, Kennedy Stinson, T. A. Morrison, John Quinlan, P. S. McKergow, Rene Lessard, J. Penrose Anglin, W. Clement Munn. Trade representatives, Messrs. Joseph Thibeault, Master Plumbers' Association; W. E. Potter, Master Painters' and Decorators' Association, Wm. Nonnenman, Mantel and Tile Dealers' Association; committee, N. T. Gagnon (convenor), W. E. Ramsay, J. E. Walsh, K. D. Church, R. L. Werry, secretary.

Engineers' Club of Toronto—Annual Meeting

At a representative and enthusiastic meeting of the Engineers' Club of Toronto, held at headquarters, 90-96 King Street West, on the evening of Thursday, February 5, gratifying reports were submitted by the Secretary-Treasurer, Mr. Wolsey, on behalf of the Directors. The Club is in excellent condition financially, there having been great improvement over the records of previous years. Enterprising measures are being considered with a view to extending the scope and facilities of the Club and important plans are under consideration. During the evening, Messrs. W. A. Bucke, D. A. Dunlap, Arthur Hewitt, Chas. H. Heys and T. S. Young were elected to the directorate, Messrs. Bucke, Heys and Young being re-elected after having served for three years. The work of the President, Mr. Burke, during the past year was eulogized in the highest terms, while generous tributes were also paid to the efforts of the Secretary-Treasurer, Mr. Wolsey, and the Directors. Mr. Willis Chipman congratulated the Club on having the most representative engineering membership of any similar organization in a city the size of Toronto on the American continent, the percentage of technical members being over eighty. Mr. Heys attributed the Club's improved financial status largely to the luncheon and dining facilities, the receipts from which had nearly doubled in the short space of a twelve-month.

The meeting unanimously approved of a proposition submitted by the Directors for a new club building.

Canadian Railroad Development

Application is being made for an act to incorporate the Northwestern Railway, a route which proposes to link up the Western province with the head of the lakes.

The Canadian Northern Railway will soon begin a train service on its new road into Calgary, which is an extension from Saskatoon across the most productive portions of Saskatchewan and Alberta.

The Grand Trunk Railway has the distinction of being the first whose design for its own exhibit building at the San Francisco Exhibition has been accepted by the exhibition authorities, who will now make this the model for each of the other companies' exhibit.

The Toronto Board of Control has decided to oppose the application to the Legislature of the Toronto and Niagara Western Railway Company for an extension of time to complete their railway. Under the Act of 1909 the company were given five years in which to construct it, which period expires on April 7 next.

The large dam across the Souris River, to the south-east of Weyburn, Sask., on which the C. P. R. has been for some time engaged, is now finished, and pumps and piping installed to connect the water supply with the railway yards. The Canadian Pacific is thus assured of one of the best water supplies on its entire system.

A report on the extension of the T. & N. O. Railway to

St. James' Bay has just been issued. There are two routes, one being described as the east and the other the west routes, and these have been investigated. It is said that the attention of the Ontario Government has been directed to Moose Factory at James Bay as the terminus of the line.

The project for a government-owned railroad in Alaska is at present before the United States Senate. The measure which is practically the same as the Chamberlain bill, would authorize the president to construct about one thousand miles of railway at a cost not to exceed $35,000,000, to connect some point on the Pacific Coast of Alaska with the interior of the territory.

The Grand Trunk Pacific Railway station will probably be the largest building to be erected in Regina during 1914. This station, together with laundry, power house and train sheds, with connecting tunnel from the station to the hotel, will cost in the neighborhood of $1,000,000. The greater proportion of the work of erecting the Grand Trunk Pacific Railway hotel yet remains to be done. Only the foundation has been completed.

Sir John Lambert Payne, controller of railway statistics, in his annual report states that during the year ending June 30 last, the mileage on Canadian Railways increased by 2,576, bringing the total up to 29,304 miles. Ontario leads with 9,000 miles, Saskatchewan being second with 4,651. At the end of the year 18,647 miles were under construction. The cost of government-owned and operated railways, representing 2,131 miles, reached a total of $126,930,887 in 1913.

St. John, N.B., Enterprise

A number of important projects have been receiving attention at St. John, N.B. The municipal council has decided to ask the Legislature for authority to issue bonds to the amount of $300,000 for a new general hospital. It has also been decided to erect this year at a cost of $50,000 a hospital for advanced cases of tuberculosis.

The municipal council and the St. John Railway Company have agreed upon terms for the extension of the street car line through east St. John to Little River, to the new industrial suburb of Coldbrook. The provincial government will be asked to ratify the agreement, so that work may be begun as early as possible in the spring and pushed forward to completion, if possible, by mid-summer.

The Fenton Land & Building Company, which in the last few years has erected forty houses in St. John, N.B., and its outskirts, has plans completed for twenty new houses to be erected next summer.

Work has been continued throughout the winter on the new St. John sugar refinery, on which more than three-quarters of a million dollars has already been expended. Two hundred men are now employed, and a great deal of construction work yet remains to be done. The steel frame of the new post office is up three storeys and shows that the structure will be an imposing one, making ample provision for the postal requirements of the city for many years to come. The contract of Connolly & Charleson, who were erecting three new wharves at west St. John, has been cancelled by the Dominion Government, and awarded to the Maritime Dredging Company, with provisions for prosecuting the work rapidly so that at least two of these berths may be ready for use by the steamship lines next winter. The construction of grain conveyors from the C. P. R. elevators to two additional wharves on the west side is now practically completed. Early in the summer work will be begun on the steel superstructure of the new street car and traffic bridge which will connect east and west St. John. The building of harbour works at St John will be conducted on a more extensive scale this year.

Personal Mention

Mr. W. J. Moore, C.E., has been appointed Town Engineer of Pembroke, Ont.

Mr. Robert Thompson, a well-known Belleville contractor, of the firm of Thompson and Donahue, died on January 28 after a short illness.

Mr. A. B. Garrow, Assistant Engineer Main Drainage Department, city of Toronto, is at present spending a few weeks' holiday in Bermuda.

Mr. Ernest E. Brydone-Jack, professor of Civil Engineering at the University of Manitoba, has been elected a member of the Institution of Civil Engineers.

Mr. J. W. B. Blackman, City Engineer of New Westminster, B.C., has been elected to membership in the American Society of Civil Engineers.

Mr. Ernst A. Richardson, City Commissioner of Saskatoon, has resigned in order to resume his connection with the G. H. Archibald Construction Company of that city.

Mr. J. T. Whitlawn, formerly chief inspector in the City Architect's Department, Toronto, died on January 30 after a long illness in the Western Sanitarium.

Mr. W. H. Woodbury, Assistant Engineer, Alberta Central Railway, Kamloops, B.C., has been elected a member of the American Society of Civil Engineers.

Mr. Andrew Broder, M.P. for Dundas, is to succeed Dr. Mills on the Dominion Railway Commission. Dr. Mills, who has completed ten years of office, will be superannuated.

Mr. C. McN. Steevens, Resident Engineer, Department of Public Works, St. John, N.B., has been elected an associate member of the American Society of Civil Engineers.

Mr. John Bell, president of the Wallace Bell Company, Limited, Montreal, artesian well drillers, died in Moose Jaw on February 1, after a brief illness. He was 43 years of age.

Mr. George Latham, a well-known Ottawa contractor on concrete construction work, is a candidate for the office of Public School trustee in Dalhousie ward of the capital.

Mr. L. W. Rundlett, city commissioner of Moose Jaw, Sask., resigned on February 1. He is now taking a vacation at St. Paul, Minn., where he may be addressed at 607 Lincoln Avenue.

Mr. John Robertson-Bird, one of the best known artists in stained glass in the Dominion, died on January 27 at Montreal. Mr. Bird, who has reached the age of 65 years, had designed the windows in many churches throughout Canada.

Mr. T. H. Drury, until recently general manager and chief engineer of the Longitudinal Railway of Chili, has returned to Canada and joined Mr. E. J. Walsh, of Ottawa, in the firm of Walsh and Drury, consulting engineers, with headquarters at Ottawa.

Mr. J. T. Breckon, formerly engaged on waterworks and sewer construction on Vancouver Island, has been appointed Assistant Engineer of the Waterworks Department at Vancouver. Mr. Breckon has had extended experience in various branches of engineering in the United States.

Messrs. Thompson, Daniel & Colthurst, architects, Saskatoon, have dissolved partnership. The practice will be continued by Messrs. T. Brammall Daniel and C. Buller-Colthurst, under the firm name of Daniel & Colthurst. The offices of the new firm are in Central Chambers, Saskatoon.

Mr. James D. Sword, a well-known consulting mining engineer and a resident of British Columbia for over twenty years, was accidently drowned while on a trip to record assessment work on a mining claim recently. The late Mr. Sword was associated with the founding of the Canadian Mining Institute.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

A new cement brick factory has been erected at St. Mary's and the plant will be in operation shortly.

For the month of January the Montreal building permits totalled $409,645, as compared with $485,600 in the corresponding month last year.

The last contract for the upper end of the Trent Valley Canal will be let this month and the work below Peterborough is expected to be completed by August, provision having been made in the estimates for finishing the undertaking.

Work will proceed this year on the new Government dry dock at Tuft's Cave, on the Dartmouth side of Halifax harbour. This will be one of the largest dry docks in Canada. The preparation of plans will be begun in the near future.

The Toronto city council has given notice to apply to the Legislature of Ontario for an Act to empower the city council to validate certain debenture by-laws passed by them and also by the Town of North Toronto for construction work amounting to over $8,000,000.

The Berlin, Ont., city council has passed a by-law prohibiting the issuing of permits for the erection of residences or remodelling of buildings for residential purposes on lanes and streets less than 40 feet in width. This measure is taken to prevent slum conditions in the city.

The Toronto Commissioner of Works has recommended that a private heating system be installed on Bain Avenue in connection with the Toronto Housing Company's development scheme. Mr. Harris stipulates an area rental to be paid in respect to the street conduit.

Plans for the proposed new sewer scheme for North Toronto are understood to have been completed by the city's engineers and a detailed report will be submitted shortly to the city council. The combined system is recommended. The estimated cost will be between three and four million dollars.

The Council of Westmount, P.Q., have decided on the purchase of a block of land between Sherbrooke street, Argyle avenue, and Cote St. Antoine road, on which to build a new city hall, light office, and fire and police station, the total cost being $300,000. This will enable the council to concentrate the various departments.

As the result of the judgment of the Governor-General-in-Council dismissing the city of Toronto's appeal against the order of the Dominion Railway Board, the city will be required to pay at least $500,000 made necessary by the increase of the headway in the Yonge Street subway at the northern grade separation, and the widening of the street from 66 ft. to 86 ft.

To provide additional accommodation a large annex has just been completed at the Windmill Point elevator, Montreal. The annex has a capacity of 1,070,000 bushels, making a net capacity of 2,150,000 bushels. There are in this new building 28 concrete tanks, 25 feet in diameter and 100 feet in height, arranged at right angles in four rows, with seven tanks in each row. The tanks are constructed of reinforced concrete, having their adjacent sides rigidly united. This is the second largest grain bin on the Grand Trunk system, the largest being located at Fort William, with a capacity of 5,700,000 bushels.

The decline in building activity in Toronto for some months past was again reflected in the figures for January which show that the value of permits issued last month was only $895,395, as against $1,276,084 in the corresponding month last year. The permits issued in January two years ago amounted to only $774,165, but with that exception the month just closed was the most inactive in several years.

The main estimates tabled in the Dominion Parliament a few days ago totalled $146,786,126 for ordinary expenditure, this being an increase of over three and a half millions. Among the largest votes are the sums for the Hudson Bay Railway, the National Transcontinental, the Halifax Terminals, the Welland Canal and the development of the national ports. The vote for the Hudson Bay Railway is four and a half millions, for the new Welland Canal four millions, for the Quebec Bridge three millions, and for the Intercolonial Railway seven and a half millions. A million dollars has been voted for the Toronto Harbour improvement.

The project for the joint construction by the governments of Canada and the United States of a deep-waterway for the ocean-going vessels from Montreal to Duluth, Minn., has been launched through the International Joint Commission which has the jurisdiction for the boundary waters of the two countries. The scheme for the ocean waterway for navigation from the head of Lake Superior to the Atlantic has been talked of for several years. Several routes have been proposed for the project the cost of which is estimated at from $100,000,000 to $300,000,000, but the one said to be the most favorable to the United States provides for the utilization of all the lakes on the St. Lawrence River.

WESTERN CANADA

Mr. W. J. Treqillus is shortly to open his new plant for the manufacture of clay products at Calgary, and it is expected that about 200 hands will be employed.

The city of Winnipeg purposes expending $1,000,000 for improvements to the light and power system. Half of this amount will be spent in constructing a new flexible tower transmission line 77 miles long.

The new drill hall for Victoria, B.C., will be commenced immediately, the contract having been awarded to Parfitt Bros. The cost will be in the neighborhood of $250,000, and it is expected the work will be completed within the year.

Following the application of the Hudson Bay Company for a permit for their new Department store at Victoria, B.C. The city council has passed an amendment making the limit 120 feet for both steel frame and reinforced concrete buildings.

The Hotel Piedmont at Calgary, when finished, will be one of the best hotels on the continent. It will be opened within the next few months. Externally the building is French renaissance. Buff pressed brick is used for the facing of the walls, Indiana limestone being used for the trimmings. The building comprises ten floors with a roof garden and sun parlor on the roof. The structure is built of steel and reinforced concrete throughout. The architects are Messrs. E. & W. S. Maxwell, and the contractors, F. Lyall & Sons Construction Company.

The annual meeting of the Saskatchewan Association of Builders' Exchanges will take place in Moose Jaw on February 16. The principal question for discussion will be the act regarding the payment of wages to employees which was passed at the last session of the Legislature.

The Greater Winnipeg Water District scheme, based on the report recommending the Shoal Lake supply, is making satisfactory progress and tenders for the following preliminary work have been received:—railway track grading and laying, including clearing right-of-way; 60-lb. rails and sundries; an 85-mile telephone line; rock core drilling near the proposed Red River crossing of the aqueduct; and five residences and office buildings. The country between Winnipeg and Indian Bay has been explored and cross-sectioned, and trial lines are being run for the aqueduct. Considerable success is being met in the effort to locate a continuous gravity flow line from Shoal Lake, the proposed source of supply, to Winnipeg. The engineers in charge of the five surveying parties are Messrs. George F. Richan, Archie Paget, Douglas L. McLean, A. C. D. Blanchard and Charles J. Bruce. The chief of design in the Winnipeg office is Mr. Max V. Sauer, and Mr. W. G. Chase, of Kerry and Chace, Toronto, is chief engineer, the consulting engineer being Mr. J. H. Fuertes, of New York.

On February 1st the Des Moines Bridge and Iron Company, of Pittsburgh, Pa., and Des Moines, Ia., adopted the name Pittsburgh-Des Moines Steel Company. There has been no change in the management of the company. The change of name has come as a natural result of the growing business of the firm which has made necessary a name that more properly describes its national scope. The company has built a large share of the elevated steel water tanks which have been constructed throughout the United States and Canada during the last fifteen years. Because of the wide territory covered, the old name was found to be a serious inconvenience, since it frequently created an erroneous impression that the home of the company was in the west. Seven years ago a plant was built in Pittsburgh, Pa., to obtain the full advantages of prompt deliveries of materials and minimum freight charges. Since that time this eastern plant has been enlarged and thoroughly equipped with all modern machinery until it has a greater capacity for steel water towers than any other plant in the country. The general offices of the company were also moved to Pittsburgh and the firm is now situated most advantageously for handling business in any part of the United States or Canada. Contracting offices have been maintained in Pittsburgh, Des Moines, Ia., Dallas, Texas, Charlotte, N.C., and San Francisco, California, for some time. And on January 1st, 1914, a new office was opened at 50 Church Street, New York City. Mr. J. E. O'Leary, who has represented the Des Moines Company in the eastern coast territory for a number of years, is in charge of the New York City office. All business in the coast states north of Virginia and in eastern Canada will be handled through the New York office.

Many railway engineers were present at the annual dinner of the Canadian Railway Club, held at the Windsor Hotel, Montreal. Mr. R. W. Burnett, master car builder of the C. P. R., presided and among the speakers were Mr. F. P. Gutelius, general manager of the Canadian Government railways; Mr. W. McNab, principal assistant engineer of the G. T. R.; Mr. M. J. Butler, president of the Canadian Society of Civil Engineers; and Mr. W. Butler.

Foundation Company's Reunion

THE presence in Montreal of many of the chief officials of the Foundation Company, Limited, was taken advantage of to organize an informal dinner at the Engineers' Club. The company, as many of our readers are aware, have carried out, and still have in hand, jobs from the Atlantic to the Pacific, and it is very rarely that so many officials meet at a common centre. Mr. John W. Doty, vice-president and general manager, presided, and among those present were Mr. Franklyn Remington, president of the company; Mr. Henry Holgate, consulting engineer, of Montreal; Mr. Lawrence Macfarlane, legal adviser; Mr. James Freeburn, an American visitor; Mr. Alexander Allaire, manager of the western branch; Mr. C. A. D. Bayley, eastern manager; Mr. R. E. Chadwick, chief engineer. The company numbered about thirty. During the evening the staff made presentations to Mr. Remington and Mr. Doty.

The following was the humorous bill of fare:

THE FOUNDATION COMPANY, LIMITED
MONTREAL - - VANCOUVER

Bill of Material

Cylinder Oil.
Hand Tools and Supplies.
Air Oil.
Mud Lake Suckers.
Generator. - Transformer.
Warning—This line carries 10,000 volts.
Cast Iron Weight avec Irish Packing.
Frozen Dynamite.
Reinforced Rubber Gaskets.
Yellow Strand, lubricated.
Frozen Concrete.
Rip Rap.
Bolts, Nuts, and Orange Peels.
Sand Hog Brand.
Spun Oakum. 10d. Nails.

Job:—Passing Show of 1913

Owner	Franklin Remington
Consulting Engineer	Henry Holgate
Legal Adviser	Lawrence Macfarlane
Underwriter	James Freeburn

Organization

Superintendent	John W. Doty
Night Superintendent	C. A. D. Bayley
Engineer	Albert Pomplin
Rodman	R. E. Chadwick
Office Man	Alec. Allaire
Timekeeper	Frany Quilter
Material Man	Frank Ross
Office Boy	L. F. Gibson
General Foreman	C. A. Wentworth
Pressure Foreman	W. I. Johnson
Master Mechanic	H. B. Kelsey
Labor Foreman	H. E. Wood
Rigger Foreman	F. S. Crowell
Sand Hog Boy	Ralph Dalton
Sand Hogs	Alec. Alexander A. A. Pitts
Pipe Gang	F. W. Schwartz R. Molstad
Shorers	C. McDonough A. S. Goodstone
Blacksmith and Helper	Carl Schelder Fraser-Campbell

An interesting new catalogue is devoted to the Shearer & Mayer Dragline Cableway Excavator. The description and numerous photographs contained in this catalogue convey an excellent idea of this class of excavating machinery and the many uses to which the excavator can be installed for the economical handling of material. The excavator is used for material which cannot be economically handled with ordinary boom line or steam shovel excavators. With this cableway excavator it is possible to dig over areas exceeding 200 to 800 ft. and to convey the material direct to spoil piles or elevate it into bins or hoppers in one operation with a double drum hoist. The machine was designed primarily for digging material over long spans from under water.

The Wheeler Condenser & Engineering Company, of Cateret, N.J., have opened an office at 122 Board of Trade Building, Montreal, under the management of Mr. Jos. McKay, Jr., who has been New York manager of the Wheeler Company for a number of years. The company make a specialty of surface and jet steam condensers, forced and natural draft water cooling towers, feed water heaters, evaporating apparatus, and special castings for chemical industries.

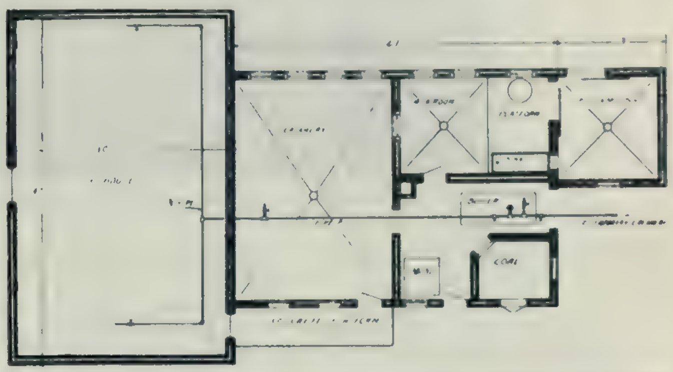
The American Road Machinery Company of Canada, Limited, Goderich, Ont., manufacturers of crushing, road-building and contractors' machinery, will start the erection of an up-to-date new plant in the spring. The building will be 400 ft. long and 110 ft. wide, 30 ft. to the square, with 70 ft. runway for electric cranes. The latest principles of design will be embodied. The building is to be of steel skeleton construction, concrete curtain walls and modern fireproofed roof. Electric power will be used throughout and a vacuum heating system will be installed in all probability. The property consists of seven acres, located on the line of the Grand Trunk Railway, so that the transportation facilities will be unexcelled. An up-to-date line of machinery is to be installed in the plant. The American Road Machine Company are the largest exclusive manufacturers of road equipment in Canada and the high grade of their products is adding to their reputation. The officers of the company are: Mr. S. Jones Philips, president; Mr. C. L. Moore, vice-president and treaserer, and Mr. J. W. Kitts, secretary.

Concreting in Cold Weather

ILLUSTRATED herewith is an ice-house and creamery at Boltonville, Vt., erected last November according to the Van Guilder Hollow Wall system of construction. The owners, H. P. Hood & Sons Company, Boston, have a number of stations scattered over several states and the above construction was selected as being particularly desirable on account of the lightness of the Van Guilder machines, their ease of transportation and simplicity of operation. The new building was to replace a small plant destroyed by fire.

The construction in this case was 4 in. walls separated by an air space of 2½ in. for insulation purposes. This double construction is particularly desirable wherever a high degree of insulation from heat and cold is desired, and it also effectually prevents dampness.

The rebuilding was delayed for various reasons until after the first of November, and as the plant was located almost at the base of the White Mountains, the builders were considerably perplexed as to how to keep the walls from freezing and as to whether they would set fast enough to allow continuous work with the wall machines.



Plan of creamery, showing temporary piping for steaming walls

As the buildings consisted of an ice-house, 36 x 45 ft., with 19-ft. walls, a creamery, 41 x 30, and a receiving shed, 13 x 15, with 12-ft. walls, there was a large exposed area to be protected, but Mr. C. D. Gilbert, representative of the Van

Icehouse and creamery, Boltonville, Vt. Walls protected and cured by steam turned into air chambers, a method which greatly extends the season for hollow wall construction work.

Storehouse for the Nova Scotia Steel and Company, Sydney Mines, N.S.

Guilder Company, was equal to the emergency. There was a boiler on the premises that had been in the burned creamery and this suggested to Mr. Gilbert that steam might be turned into the continuous air space and the walls steam-cured. Plenty of old pipe was at hand and lines were run so as to reach every part of the building by means of steam hose connected to the walls. As fast as they were built the walls were covered with strips of tar paper, weighted with boards, and steam was turned on, with the result that the concrete set in about three hours so as to allow another course to be laid and was past danger of freezing in six hours. The entire walls were erected in three weeks. The thermometer went as low as twenty degrees and at one time there were four inches of snow, yet the work was carried on successfully.

This is claimed to be the solution of the problem of how to protect and cure double concrete walls in cold weather, and doubtless it will result in extending the season for this type of construction work. In fact this steam-curing process should place concrete in its proper place among building materials where double walls are specified, as it can be used in any weather suitable for other construction work.

We also reproduce a photograph of the store house built according to the Van Guilder system for the Nova Scotia Steel & Coal Company, Sydney Mines, N.S.

An up-to-date concrete products plant possessing excellent facilities is that of the National Concrete Manufacturing Company, Limited, Lindsay, Ont. (Mr. H. V. Pogue, President). Built on the G. T. R. main line to Toronto, this plant is claimed to be the most modern in the province for the manufacture of concrete pipe, building blocks, block silos, concrete fence posts and drainage tile. The company also supply special goods such as trimmings for public buildings. The raw material used is the best Portland cement and choice graded sand and crushed stone, so proportioned as to make the lowest percentage of voids and the strongest aggregate. The system of steam-curing employed by the company is the last word in curing concrete goods and is said to be more effective in 48 hours than "a month of weather." The company manufacture heavy railroad pipe in sizes from 12 in to 36 in., according to specifications and all sizes of culvert and sewer pipe from 6 in. to 36 in All the larger sizes are reinforced to standard specifications and special reinforcing is given on application. The company's goods are made on cars which are run directly into steam kilns for 48 hours before yarding, leaving them ready for immediate shipment. The dimensions of the plant are 118 ft. by 84 ft. and the storage yard covers several acres.

Roofing Firm's Extensions

Messrs. Bird & Son, Hamilton, are now at work on an extensive addition to their present large plant. These additions are to take care of the increased demand for Neponset waterproof wallboard and for the Neponset shingle which the company is bringing out. Mr. George E. Messer, Canadian Manager for the company, states that the firm is erecting an addition to the plant which will cost about $15,000, and will install machinery at a cost of about $10,000. In addition to the various articles manufactured by the firm, it is the intention to place Neponset shingles on the Canadian market. These will be the first of the kind to be made in this country. The work of putting up the building will be rushed to completion as speedily as possible, and the hope is entertained that the new machinery which the firm will install will be in operation in a few weeks.

The company are sending a traveller to Australia, where he will spend a year in the hope of increasing the trade in that country. The traveller chosen for the work is Mr. H. F. Nobles, of St. John, N.B., who has covered the eastern Canadian route from the Hamilton office for the past two years. Mr. Nobles will go to London, Eng., where he will meet the European representatives of the company, and will then proceed to his destination.

Erratum.—The Aberthaw Construction Company, contracting engineers and concrete specialists, Boston, Mass., inform us that the building described in Fig. 30 of the illustrations accompanying the article, "The Descriptive Possibilities of Concrete," published in our issue of January 14 and 21 last, was that of the Pierce-Arrow Motor Car Company, Buffalo, and not that of the Packard Automobile Company, as described below the cut. The former building was built by the Aberthaw Construction Company in 1910.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 February 18, 1914 **No. 7**

Principal Contents

Maladministration at St. Boniface .. .., 191
Inviting Tenders by Correspondence 192
Fees for Professional Services 192
Engineering Topics in the Old Land 193
Concave Roads Discussed by our London Correspondent.
Letters to the Editor 196-199
Details of Road Work—The Design of High Buildings—Quantity System.
Crushing Plant of the Martin's International Trap Rock Company at Bruce Mines, Ont. 199
Port Alberni and Salmon Arm Waterworks 200
"Vibrocel" System of Reinforced Concrete 202
By J. E. Holdcroft
Digging Trenches and Holes in Frozen Ground 206
Ten Rules to Eliminate Building Failures 207
Suggested Designs for Sewage Treatment Plants for Residences and Small Institutions 208
Toronto Stock Exchange New Building 211
Construction of Creosoted Wood-Block Pavements ... 212
By R. S. Manley
Sketch of Mr. M. J. Butler, New President Canadian Society of Civil Engineers 213
Credit Foncier Building, Vancouver 214
Concreting in Winter 214
New Vancouver Car Barn of the B. C. E. R. 215
Vancouver Builders' Exchange—Annual Banquet 215
Constructional, Personal and Industrial 216-220

Maladministration at St. Boniface

EXCESSIVE taxation was one of the principal matters upon which Mr. Chas. Curtis, of Winnipeg, reported at the instance of a representative body of the ratepayers of St. Boniface, Man. The principles underlying the observations of Mr. Curtis have already inspired a number of editorials in this journal, but the report contains much original matter—particularly in regard to contract procedure—worthy of further consideration.

At the outset, Mr. Curtis compares the St. Boniface tax rate of 24 mills with the Calgary rate of 18.75 mills, the Edmonton rate of 16 mills and the Regina rate of 14 mills. Much of the high taxation is attributed to lack of competition on city contracts resulting from an apparent understanding between the council and the officials that invitations to tender are not to be extended to outsiders except in the case of work which is too large or too complicated for local contractors. In support of the contention that this is poor business policy and that it not only keeps up prices but encourages collusion among contractors, Mr. Curtis maintains that the city of St. Boniface has been paying at least 10 and in some cases 25 per cent. more for its work and material than it would have done had it advertised in accordance with the practice of other municipalities. In further detail, Mr. Curtis states that an examination of the file numbers of the Contract Record for 1913 reveals the fact that during the twelve months ninety-five municipal and other authorities advertised for tenders in this journal, the contracts for the various work representing an expenditure of approximately $250,000,000. The only time that the name of St. Boniface appeared was in connection with a contract for bridge piers and this was done because no local contractor could finance the undertaking. The solitary advertisement, however, resulted in the successful tenderer, an outside firm, being $92,000 lower than the next bidder. "It is not unreasonable to assume," comments Mr. Curtis, "that this sum was saved by throwing the work open to general competition." The report continues that a ten per cent. saving on the contract prices of local improvements carried out in St. Boniface would have enriched the city's treasury by some $250,000.

Strong arguments in favor of appointing a city manager are brought forward by Mr. Curtis. The various committees, excepting the finance committee, should be discontinued, he contends, and there should be a city manager over all departments. This system has been tried in a great many cities—both United States and Canadian—and always successfully, where the official has been paid adequately and endowed with proper authority. Regina, which is governed by commission and council, with Mr. L. A. Thornton really in the position of city manager, is cited as one of the best examples of this form of government. Regina also has a finance commissioner and has lately decided to abolish all committees. At Westmount, Que., where there is a city manager, the most satisfactory results have been obtained, according to a report presented by Mayor MacKergow at the recent session of the National Municipal League in Toronto. The Mayor of Westmount expressed the opinion that the affairs of the city required quite as much expert attention as those of any private corporation.

"The city you live in," says Mr. Curtis to St. Boniface, "can be likened to a huge corporation of $25,000,000 paid-up capital, with you as individual shareholders. Would you as shareholders of a company of this size—or of two millions for that matter—be in favor of running your company with a president and directors who were at work a few hours a day, or possibly not at all, and perhaps at night when the works were shut down? Of course you would not. Then why should you be satisfied to run your city that way? Would you expect results if you paid your directors a few hundred dollars per annum for their services? The only common-sense system in any business is to get experienced and able men and to pay them well for their labor." Mr. Curtis suggests that a solution of the problems that have arisen at St. Boniface may be found in the appointment of a first-class executive engineer to administer the affairs of the city.

It may be mentioned that an editorial paragraph relating to the "city manager" plan which has just gone into effect at Dayton, Ohio, appeared on page 61 of our issue of January 21. We are of the opinion that this system is peculiarly adapted to a city of the size of St. Boniface and in fact to all other municipalities whose funds will not run to employing other than mediocre men who have not the courage to demand final authority in the administration of their own particular business. Therein, perhaps, lies the secret.

In the preparation of this report Mr. Curtis has rendered an appreciable serrvice not only to the city of St. Boniface, but to every Canadian municipality desirous of introspection.

Inviting Tenders by Correspondence

IN our last issue, speaking of the promised activity in road work, we mentioned a few of the items included in the programme of construction drawn up by the Quebec government. Among the work to be undertaken is a stretch of some thirty-two miles of macadam or gravel on the Sherbrooke-Derby-Line road. It would be natural to expect that tenders would be taken for the larger items, but in regard to this particular work, at any rate, we have it from an authoritative source that tenders will be "invited by correspondence." It is possible that the government may have well-defined reasons for cutting up the work into sections and awarding it locally, but as a general principle, in our belief, the system is altogether wrong. There have been countless evidences of large sums which have been lost through carrying out work privately, while the examples of unsuccessful contract work have been remarkably few. The pros and cons in this argument have been discussed at such length, and so often, in these columns that our point is sufficiently emphasized by merely mentioning the matter and citing it as an example to avoid. The trade and technical press is the established medium between the parties to a contract, and its functions cannot be usurped by correspondence. In the interests of all concerned it is to be hoped that in this case the "correspondence" will extend beyond the favored few who usually receive such notification.

It pays to advertise—especially when the advertiser has something of value to dispose of; chooses his mediums with care, preferring the daily and trade papers to all other mediums; keeps posted as to which publications are rising in character and circulation and which are declining; tells his story in a simple, concise and convincing way; takes enough space to tell it; keeps at it persistently; creates an efficient organization to handle his advertising; rejects all mediums whose main appeal is on the score of cheapness, and, finally, is willing to co-operate with the publisher to secure the best results.

Engineers' Fees

ONE of the most troublesome questions to a practising engineer is that of fixing the amount of the fees that he shall ask for his services. If he charges too much he loses work. If he charges too little he loses the respect of his client. The same man often errs in both directions at different times. In the serious endeavor to find a reasonable middle course he receives little aid from the engineering societies. Their membership is made up in large part of those who receive fixed salaries, who are contractors, or who are in other businesses, and this condition makes it impracticable for them to deal effectively with the question.

The engineer often envies the architect, who has a much more definitely fixed schedule of fees; but it seems hardly possible to use an equally definite schedule in engineering. This is particularly true of preliminary and special work not involving designs or the supervision of construction. Work of this character, although it does not pay the largest fees, is one of the most important from the standpoint of the development of natural resources.

The question is a most difficult one if the rate of compensation must be fixed in advance. This is because of the uncertainty as to the amount and kind of work that may be required. Good business men engaging engineers often want to make arrangements that fix definitely the amount of compensation that they may be called upon to pay. Such limits are often necessary, especially in public works and where work must be done under a limited appropriation. The engineer wants to meet his employer in this, and often goes farther than he ought.

The cases are common where an engineer, in order to meet competition, or, in the absence of sufficient knowledge as to what will be required, undertakes work for a fixed fee that proves to be inadequate. He then usually does as much as he thinks he can afford to do; sometimes he does much more; but it often happens that this is too little and the client is dissatisfied, not because he is paying too much but because the engineer is doing too little. In such a case an adequate fee would be equally advantageous to both parties. Cases of this kind are far too common.

If the work to be done is of a nature so definite that it is possible to know in advance just what is to be done, then the rate of compensation may be fixed with less likelihood of injustice. This is true of the work of making detailed plans and of superintending construction. In many other cases the nature of the work is not known and cannot be known in advance. The client knows that he is in trouble and needs help. He thinks that the engineer can help him. What the engineer can do remains to be determined by trial. It may turn out that the engineer is able to do, and actually does do for him, something that was not contemplated at the time he was engaged, and that it is much more useful than the work that was contemplated. Under such conditions the impracticability of fixing adequate compensation in advance is obvious.

The commonest way of meeting these uncertainties is by the use of per-diem rates. The plan of charging for professional services according to the time spent is accepted as an expedient. As such, it perhaps comes nearer to satisfying some of the impossible conditions of the case than any other feasible method. It fails to meet the requirement of the client for definiteness because no one can tell in advance how much time will be required. It also frequently works injustice. If an engineer, by reason of possession of special information and experience, is able to render services of substantial value to a client, the fact that only a little of his time is required should not operate to prevent his receiving a substantial fee. On the other hand, every engineer in active practice is sometimes connected with work which for one reason or another is less profitable than usual to his client, and in such cases, in a spirit of fair play, the engineer's usual per-diem rate may represent more than a fair fee.

It is far easier to determine what a fair compensation is after the services are rendered. Then all the essential elements are known with more or less definiteness. Some of the most important engineering work is performed without other arrangement between engineer and client than the understanding that there is to be fair play and that the charges will be reasonable. Under this plan an engineer can often render valuable services to his client which would not be possible if he were restricted in what he may charge by an agreement made before the conditions were known. When the client and engineer can trust each other fully this method has great advantages. Under it there is better chance of the fullest service and the greatest advantage to both parties. In other professions the advantages of this method, or perhaps the difficulty of other methods, is so great that it has become customary, and attempts to fix compensation in advance are unusual. No one expects a doctor to name beforehand the fee that he is to receive when he is called to see a patient.

One reason why engineering work is not more frequently performed in this way is because clients and engineers have not sufficient confidence in each other. The reason for this may be found in the great diversity in the kinds of engineering work, in the fact that work of a particular kind is often widely scattered, and that the engineer and client seldom know each other as well as men are apt to know their lawyers and their doctors.

Whatever the cause, this lack of confidence is unfortunate and tends to limit the field of usefulness of engineers. This is one of the matters that must be worked out and corrected. Doing it will add to the dignity and usefulness of the profession. The engineer must be faithful to his client's interest all the way through, up to and including the amount of his charge, and must deserve the confidence and trust of his client. On the other hand, if clients can be induced to take the pains to select engineers whom they can fully trust, it will go a long way toward bringing about better conditions.—Engineering Record.

Engineering Topics in the Old Land

Concave Roads a Solution of the Problem of Relieving Traffic Congestion—An Opportunity for Experimental Work in Canada

By our London Correspondent

IF, as was said in a previous letter, "it is somewhat difficult for the English mind to realize the resources of such a country as Canada," it is still more difficult for the Canadian mind to realize the lack of resource in such a country as England. London's traffic is a case in point. Within the metropolis, one reads in the report for 1913 of the London Traffic Branch of the Board of Trade, the number of passenger journeys made by road has almost doubled during the last ten years, while within the same period the total number of street accidents also has doubled. The actual number of passenger journeys by tramway and omnibus during 1912 was 1,349,109,979, or thirteen and a half hundred million. The total number of street accidents in the year was 22,261, of which 561 were fatal. The general conclusion drawn by the report is that "there is a very grave and sudden rise in danger as soon as traffic conditions tend to become congested, due to the large volume of mixed traffic moving at speeds varying between wide limits." The obvious remedy would be so to disentangle this mixture of traffic that fast and slow vehicles ran in definite tracks, and it is therefore astonishing to find among the suggestions put forward for relieving congestion "that slow traffic be compelled to keep to the kerb." It may be said at once that that is the rule now, and the anomaly is presented of such fast traffic as motor omnibuses and taxi-cabs having to break the line of slow moving vehicles on every occasion when passengers are to be picked up or deposited. Frequently—more frequently perhaps—the fast vehicle cannot reach the kerb, and then comes not only the danger to the passenger but a temporary impeding of the progress of several lines of moving vehicles. The obvious remedy is to have the fast traffic keeping to the kerb; but to bring this about the present cross-section of London streets would have to be reversed.

Concave Roads

In the adoption of the concave road is to be found the only solution of the problem. Here, in England, engineers are content to rub along in the old groove. Innovation does not appeal to them, and had it not been for the advent of the motorist (who is not an engineer) roads would undoubtedly still be made of water-bound macadam. There is no lack of talent in the country, and technical ability of a high order is the rule and not the exception; but engineers are obsessed by the old bogie of conservatism. Too, it is difficult for the highway engineer to make a departure from existing methods, and the man who would be bold enough to construct a concave carriageway would run grave risk of enforced resignation. Ten years ago, when motor traffic was quite in its infancy, the present writer advocated the adoption of the concave system, and every point he then urged in its favor—decreased initial cost, increased comfort, safety and convenience to pedestrians, decreased dislocation of traffic, speedy

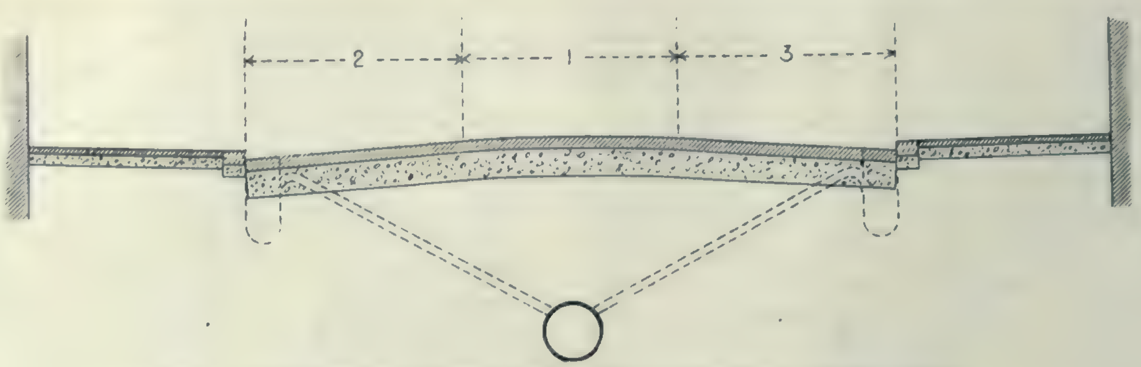


Fig. 1—Cross-section of street with convex carriageway and side gulleys.

removal of slop (by washing to the centre of the road), and facilities for dealing with heavy snowfalls (by ploughing to the centre of the road and piling clear of pedestrians)—applies now with tenfold force. Among the arguments usually advanced against the concave road one of the most fallacious is that regarding cross-section. As will be seen from the accompanying sketches the cross-section, in so far as fall or camber is concerned, would remain precisely the same. In Fig. 1 we have a common form of convex road, composed of two straight lines, joined in the middle by a curve and having a fall to the channels. Cut this now into three equal parts, invert the crown and transpose the sides (Fig. 2) and the required concavity is obtained. The road, carved thus out of a convex one, will have, so far as the haunches are concerned, precisely the same falls to the new channel; whilst the inverted crown will have no more tendency to cause the traffic to slide than it did in its original form, being simply an inverted arc of the same radius. It is scarcely necessary to point out that a concave road would be centrally drained, and that all mud and slop would have a tendency to gravitate automatically towards the centrally-placed gullies, away from the pedestrian side-walk. Safety to life and limb must be the first consideration, however, and this requirement the concave road fulfils admirably, by relegating the slow traffic to the centre of the carriageway and allowing the passenger to enter and leave the licensed vehicle direct from the kerb. Perhaps some Canadian engineer will report favorably to his municipality upon the subject, with a recommendation that a trial section be laid in some busy thoroughfare. The experiment would be watched with the keenest interest here. Tramway tracks must necessarily present some difficulty, but these are always a nuisance to be reckoned with, and it is to be hoped that the day of the flexible trolley-omnibus is not far off.

The Woman Engineer

It would have seemed a far cry, a few years ago, from concave carriageways to the question of votes for women; but we move in speedy times. It is not long since that a woman was in the running for a county surveyorship in Ireland, and a certain Mrs. Greathead holds now the position of clerk to the Reeth (Yorks) Rural District Council. From the recently issued Blue Book of Occupations and Industries in England and Wales, we see that there are no fewer than 86 women plumbers in the country, of whom 77 are either maidens or widows. Such facts are disquieting or the reverse according to one's opinion on the women question; but they point to the certainty of women municipal engineers, just as there are women sanitary inspectors, plumbers and council clerks. Women suffragists in the Dominion are, we are assured here, elated at the sweeping victory achieved by "the cause" in the Toronto municipal elections, and with a preponderance of women upon local bodies the appointment of women to as many paid positions as possible is at least within the range of practical politics. The women are now, we understand, to advance to further conquests, among which the Parliamentary franchise looms large. The slow-moving traffic is usurping the place of the fast with a vengeance!

A Plea for the Round Figure

There was a story current a good many years ago concerning a certain Chancellor of the Exchequer who, being confronted with a page of figures which had been brought out to decimals, inquired what all those "damned little dots" were. There certainly is a tendency to use these "little dots" much more than is ne-

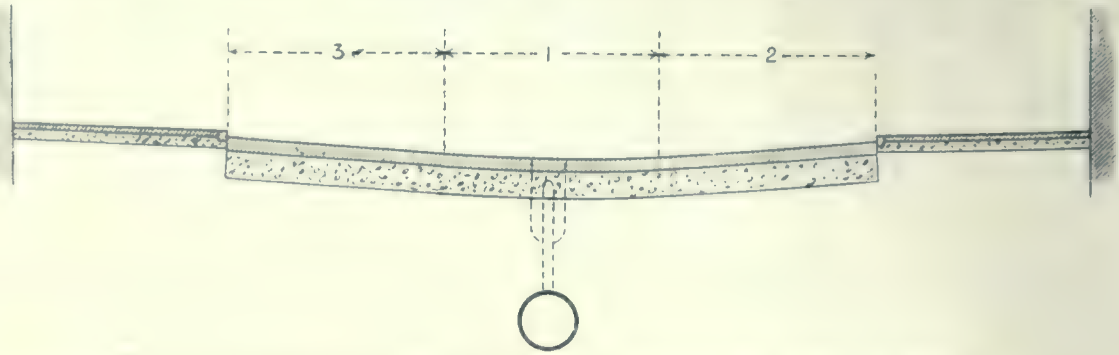


Fig. 2—Cross-section of street with concave carriageway and central gulleys.

cessary. Thus, one reads "The net earnings of the department for light and power is $72,032.06, an increase of $30,842.50 over the net earnings of the same month in 1912." The same pandering to unnecessary detail has place here, and such items as £2,490,133 17s. 4d. appear with startling frequency in government and municipal publications. The Decimal Association is doing good work in this country, and the day may arrive when our obselete system of weights and measures will be relegated to the scrap heap; but meanwhile a Round Figure Association might find plenty of useful spade work to do. Surely, in the instance quoted above, $72,000, $31,000 and £2,500,000 respectively would have served the purpose equally well. Such figures are published for general information, and the mind rejects them when overloaded with detail. The requirements of book-keeping are quite another matter.

The Road Board

State, as opposed to local, control of roads is one of those big questions that cannot be dealt with in the space of a paragraph or two. Opinions in this country have always been divided upon it, but the ranks of the adherents of local control have been much swelled since the formation of the Road Board. Any body having an exaggerated idea of its own importance can, by the issue of formidable reports (with detail figures and "little dots" galore) impress those who are not "in the know." The work of the Road Board has been one of incapacity, muddle and failure, and its name is a byword among engineers here. It was formed in 1910, and its members consisted of a railway director and manager, a shipbuilder and owner, a "Lord Justice Clerk," a "Lord," and a "Baronet." The Board, in its wisdom, appointed an electrical engineer as consulting engineer, and this precious combination got to work with a speed that raised glowing testimonies on almost every side. Among the whole of the technical journals of the country, there was only one that had the courage to make a stand against the flagrant jobbery of the appointments, while highway engineers and surveyors meekly furnished all the information asked for by the Board. The motorists ran the Board from the day of its inception, as they do to-day, and for some months it confined its attention to the rounding off of such corners as were a source of danger to the motoring fraternity. Then came a few rapid motor tours through some of the counties of England, and hundreds of miles of road were reported upon not only in record time but by quite incompetent men. "If the matter were not such a serious one for the community," said the journal to which reference has been made, in connection with some experiments that the Board were to carry out, " it would form an excellent piece of Gilbertian fooling." This journal consistently opposed what it termed "the preposterous constitution of the Board," with the result that later an Advisory Engineering Committee was appointed. Even with this wealth of engineering ability to aid in its deliberations, incredible follies have been committed, for the simple reason that the Advisory Committee is kept well in hand and the motoring interests receive preferential hearing. The trial sections of roadway laid at Sidcup form an excellent example of practical fooling.

An Object Lesson for Canada

A writer well-qualified to speak said only the other day: "I doubt myself if the Road Board has discovered anything that can be regarded as strictly new, for several of the proprietary processes it has been the direct means of procuring contracts for were well-known to local authorities before they were recommended by this august body." And again "My bone of contention against the Board has always been that practically the whole of its work will have to be done over again in the near future for the reason that it is not making use of its powers to adequately widen the roads to meet the conditions a decade hence. The Board is still without a policy on which to proceed; it is content to leave the roads as narrow and as tortuous as they were; the hedgerows have not been clipped, and little provision has been made in the matter of side paths for pedestrians." The procedure of the Board is rendered delightfully simple by the entire lack of knowledge on the part of its permanent officials. Thus, a local authority asks for assistance in carrying out certain highway improvements. "How much will they cost?" asks an official. £1,500 is quoted. "Give you £200," replies the official, and then follows a little bargaining, and the harassed authority agrees finally to accept £450. There was really no more reason for cutting down to £450 than to £200. It is merely a game of bluff, in which engineering skill has no part. The Road Board spells state control of roads in the end, for the Board is even now endeavouring to obtain control of county appointments, and it is meeting with a measure of success. Board control means that prominent motorists and superannuated army officers will receive the pick of the jobs. The trained surveyor, as a man knowing his work, will be left quite out in the cold. Canada may some day be considering the formation of some body akin to the Road Board, and this brief history of that notorious Department may serve as some guide to what to steer clear of.

The kind of English which we desire to see more extensively in use among Canadian business staffs, says The Financial Times, is not the English of the pedantic precisionist who goes through life in horror of using the wrong preposition in a compound verb-phrase, or putting the preposition at the end of the sentence, or splitting an infinitive, and is afraid to use "and which" even where that collocation is perfectly lawful. Such an attitude nearly always proceeds from an imperfect education—an education which has failed to reveal the fact that the English language is a natural growth of the human mind, and not a system of unalterable and uncontradictable rules like arithmetic and geometry. The kind of English which we want is the English of men who realize that the sole object of language is to convey thought, and who pay some attention to their sentences in order that their thought may be conveyed as clearly and vividly as possible, not in the set phrases and catch-words of a textbook but in words appropriate to their own ideas.

Experience seems to show that with concrete floors it takes a longer time to heat up a structure for the first time than in the case of wood floors. However, after the building has once become thoroughly warmed it requires much less heat to maintain a constant, comfortable temperature than where mill construction is used, so that the heating account in the long run appears to be considerably cheaper with concrete than with mill construction. Concrete Age claims that where the heating expense is of considerable magnitude this feature might very properly be seriously considered in the choice of building material.

LETTERS

Trap Rock Defined

Buffalo, N.Y., Feb. 6, 1914.

Editor Contract Record:

Will you kindly furnish us with a definition of "trap rock," and oblige.

Yours truly,
Oneida Lime Company, Limited.

Trap rock is a rather general term and usually includes all rock that is hard, tough and dense and cracks with an irregular jagged fracture. The geologists would perhaps classify it as Syenite, Diorite or Gabbro. Road men usually include all Igneous rock that are dark in color as trap.—Editor.

Highway Work in Saskatchewan*

Regina, Sask., February 10th, 1914.

Editor Contract Record:

In accordance with your request I herewith submit a concise statement covering the programme of the Highway Commission of this province for 1914.

The amounts voted by the legislature for Public Improvements in 1914 are as follows:—

Chargeable to Income	
Roads and Bridges	$500,000
Ferry accommodation	90,000
Chargeable to Capital	
Steel bridges on concrete abutments	$300,000
Construction and improvement of public highways	1,200,000
	$2,090,000

The above figures include the entire cost of administration.

It would be a very difficult matter to give you any approximate figures as to mileage. Regarding the class of construction, I may say that we intend to follow along the lines pursued in the past few years. Saskatchewan has not yet reached the Macadam stage of road construction. At present practically all our roads are of earth construction.

I expect a great many miles of new prairie road will be opened up this season while, of course, the maintenance of those already constructed will require considerable attention.

In bridge work we expect to undertake the construction of many wooden bridges on pile foundation and a few steel bridges on pile foundations. These are under the heading above "Chargeable to Income."

Under Capital Account we have an appropriation of $300,000 for steel bridge on concrete abutments. The illustrations shown in our annual report 1912-13 will best describe the class of bridge we are constructing from Capital Account funds. We have not completed our programme as to location of highway improvements or location of bridges.

It may be interesting for you to know that we are arranging for another road drag competition for this season and expect many more municipalities to enter. The province will be divided into districts after all entries are made, inspection will be made before the dragging operations are commenced, immediately after, and periodically from June until the latter part of September. Four prizes, ranging from $400 down, will be given in each district to the municipalities gaining the greatest number of points. The results of the road drag competition held last year show that it is the only solution of road maintenance, especially where so much clay and loamy soils are encountered as in this province.

I trust that this outline will be of interest to you and your readers.

Your obedient servant,
H .S. Carpenter,
Acting Chairman of the Board.

Westrumite—A Correction

Winnipeg, February 6, 1914.

Editor Contract Record:

We note that in a recent issue of your journal, in your "Glossary of Terms Used in Road Construction," you state that Westrumite is "the trade name of a mixer." This is news to us, and we would like to tell you what Westrumite is. It is an asphalt used cold for laying pavements, thus making it possible for the small community as well as the large city to have first-class asphaltic pavements at moderate cost. Westrumite, ordinarily, is laid two inches thick as a wearing surface on either concrete or macadam foundation. It makes a dustless and noiseless pavement, and the granular texture of the surface prevents slipping and skidding, even when completely covered with water. Westrumite pavements are suited to all climates; they are not affected by heat or cold; they neither track in the summer nor crack in the winter.

Yours very truly,
Westrumite Asphalt Paving Company, Limited.

Additional information about Westrumite and any other form of construction is welcome, but the definition complained of in our correspondent's letter was given in error owing an oversight on the part of the proof-reader. Upon turning up the original manuscript we find the following lines:—

Westrumite.—The trade name of a dust palliative.
Whalley Mixer.—The trade name of a mixer.

We are glad to have this correction and hope that the Westrumite Asphalt Paving Company's example in writing us will establish a general precedent.—Editor.

"Vulgarity and Obstrusiveness in a New School of Design"

Montreal, Feb. 12th, 1914.

Editor Contract Record:

The subject you raise under this heading in a recent number of your paper is a live topic and one that is causing a good deal of interest at the present time.

In commenting on the subject one cannot get away from the fact that skyscrapers, or at least high office buildings, have, of necessity, to become sooner or later part of our street architecture in most of our large cities. They naturally arise where the business centre is small in area and sites for good offices are limited and of high value.

The questions that govern the height and surroundings of office buildings should be taken up seriously by the municipal bodies who have the making of the laws governing the erection of such buildings.

A well-designed skyscraper like the Woolworth Building of New York—if detached—or an office building, such as those referred to in your article, at Toronto—have nothing whatever in themselves to criticise adversely as architecture, but what is serious is the placing of these high buildings indiscriminately in narrow streets.

One hardly realizes what is going to happen in our already crowded streets when several of these buildings are placed close together. In New York and other cities in the

---

*Mr. Carpenter's communication will cover, at least in part, several recent enquiries touching upon roadwork in the west.

States are many cases where two office buildings adjoining one another, or on opposite sides of the streets, have a day population of 5,000 people—a number that in a city like Toronto or Montreal would a few years ago have been spread over a square mile or more of their business streets.

What congestion will occur around these high buildings in our Canadian cities if they are allowed to be built in close conjunction to one another is not considered to anything like the extent it should be by the exponents of the commercial tower.

Architecturally speaking, our business streets require to be treated essentially in a formal manner. Even with high office buildings, a height should be set down by our building authorities to which all buildings should be governed. A defeat of efforts to establish such a limit can be due only to the strength of private interest. The larger public interest is in favor of the restriction.

Tall buildings require a wide street quite as much because of the congestion of travel they bring as because they shut the sunshine out of a narrow street. For this reason, if for no other, a 22-storey building is too high for a street the width of King Street, Toronto, as a 12-storey is in Montreal for a street the width of St. Francois Xavier. As before mentioned, a formal treatment is desired in our business streets, for nothing looks so bad as to see a high and low building in close contact with on another. Such a bad arrangement has been compared to a line of type where the letters are all different in height. Whilst the letters need not be exactly the same form and width, no glaring contrast should be allowed to shock and offend. A uniformity of height or relation to one another of adjoining buildings is being insisted upon by the powers-that-be in our older cities, especially where modern improvements are being made. One recalls the recent rebuilding of the lower end of Regent street, London, England, and the Crescent of Aldwych, where the skyline for the whole of the new buildings was governed by a previously well designed and carefully prepared scheme. This scheme was made in accordance with the views of leading architects and engineers who had been called together by the municipal authorities in consultation. Where such a scheme has not been followed we know only too well how our business streets have become a total failure artistically.

Unless our municipal authorities are broad-minded enough and courageous enough to look forward twenty years or more into the future when undertaking problems for their city's good, I fail to see how our cities are going to develop to the best advantage on sound national and aesthetic lines. Would it not be possible and desirable for each of our municipal councils to have prepared by the best authority available a well-considered plan showing upon what lines it is desirable for the city to develop in the future. Then, after this scheme had received the general approval of the public, all future improvements, buildings, etc., would be for all time based and governed by such a plan. Restrictions in such a scheme would have to be made, but consider what the future ratepayers in a growing city would be saved in avoiding the many expenses found to be necessary now-a-days for street widening, cutting through of new streets, and other such public works.

A city developed on such rational lines, with the necessary open spaces and different types of buildings related to the width and position of the streets in which they are placed, would be a pleasure to behold.

Those that come after us would then feel proud to live in such a city—where foresight and common-sense had played so important a part in their forefathers' time, whereas now we ought to hang our heads at the lack of uniformity in our streets and the glaring contrasts in the types of the buildings which can but shock and offend.

In New York the public authorities are considering this problem of restricted heights for buildings. Mr. R. P. Bolton has recently sent to the Borough President a report on the subject of which the following is an extract:

"I have suggested to the Commission a limitation of nine times the gross plot area in gross interior floor area. Coupled with a restriction as to cornice heights and permission to build higher only by recession from all sides of the property lines, the access of light and air to street and neighbors would be secured.

"With the increased high cost of construction, it follows that rentals must be high if a proper return is to be secured, but it is a fact that the mere height of buildings does not bring in commensurate returns. There are actually instances in lower Manhattan where the lower floors of some skyscrapers are unrentable as office space and are rented for storage purposes on account of the insufficient light and air they afford.

"This is due to the building itself, which has not only robbed its neighboring properties of their share of light, but has robbed itself of its own share of reflected light. The same applies to access of air for ventilation. Had such buildings been constructed with regard to these features, a much less height would have been found to produce equal results."

This statement is interesting as dealing with the question under discussion and raises important details which it is well for all to consider.

Yours truly,
Philip J. Turner, F.R.I.B.A.

Tentative Basis for Proposed Quantity System

Editor Contract Record:—

It has long been a matter of wonder to many of those identified with architectural and building work that the duplication of labor and liability to error obtaining under the present haphazard methods of estimating should be allowed to continue, and in the light of this your recent editorial references to the subject are gratifying.

Any system introduced into this country must be formulated upon the basis of our present practice in estimating and adapted to the peculiar requirements of our methods. A brief review of the English system will, however, prove illuminating and will plant the red flag over the pitfalls to be avoided in any constructive work.

The quantity surveyor in England receives a fee based upon a fixed percentage of the cost of the work. The fee is placed at the bottom of the money column in the bill of quantities and is added to the total amount of the estimate. The successful bidder pays the surveyor's fee. If no contract is let, custom has established the right of the quantity surveyor to collect his fee from the owner. In the one the case the owner pays the fee indirectly, and in the other, he pays it directly. Is there any logical reason why the fee should not in all cases be paid directly by the owner? The conditions of payment under the English system inject into the situation an element of uncertainty as to who does actually employ the quantity surveyor. The courts have held that the architect employs him with the implied authorization of the owner. Nevertheless, in many cases where the bill of quantities has proved deficient, the contractor has believed that he had the right of recovery against the quantity surveyor since he was paying for his services. The question will immediately arise in the mind of the reader: "Why should there be any dispute as to the sufficiency or deficiency of the bill of quantities?" The answer is: that the bill does not constitute the basis of the contract. Here is the most glaring inconsistency in the English system, precipitating innumerable disputes and litigations. English practice is to compute the estimates solely upon the bill of quantity. The drawings and specifications are not issued to the bidders, but are on exhibition at the quantity surveyor's office. The estimate and contract, however, place upon the contractor the obligation to complete the building in accordance with the plans and specifications for the amount of the estimate. It is obvious that if the estimate is computed upon the basis of the bill of quantities, the bill of quantities should also constitute the basis of the contract. The lump sum tender should be done away with.

As stated before, the quantity surveyor in England is employed by the architect and paid by the contractor. Payment generally signifies employment; but the English courts have, in only a very few cases, held the quantity surveyor responsible to the person paying him for his services, and in these cases only because he has been guilty of flagrant negligence or gross incompetence. Such a condition will always have the tendency to induce irresponsibility in the quantity surveyor.

As a tentative basis for working out a quantity system, the following code of rules is proposed to govern the employment of the quantity surveyor and the adoption of the quantity system of estimating:

(1) That the quantity surveyor receive a stipulated fee to be paid in all cases by the owner.

(2) That the bill of quantities constitute the basis of the contract—a definite amount of work for a definite amount of money.

(3) That the drawings, specifications, and bill of quantities be issued for the purpose of bidding. The drawings and specifications are essential to the intelligent pricing up of the bill of quantities, since they serve to illustrate the manner in which the materials are to be worked and their character.

(4) That the owner assume responsibility to the contractor for the accuracy of the bill of quantities.

(5) That the quantity surveyor be obliged to pass a state examination and receive a certificate, as does the certified public accountant, before he be permitted to practise, thus establishing his competency.

Let us now consider the various aspects of the operation of the quantity system under the proposed code.

The owner may be expected to object to being put to the supposed additional expense of the quantity surveyor's fee. This objection is quickly disposed of by studying the economies of the present system. Sufficient statistics have been collected to indicate that in this country there is an average of ten bidders for each job put out for estimate. Following the law of averages, each bidder secures one of the ten jobs on which he submits estimates. The cost of preparing all estimates is charged to "overhead" and distributed pro rata over all of the work actually secured. Therefore, the cost of estimating the nine jobs lost is charged against the one job secured. No matter what obscure method of bookkeeping is followed, in the last analysis the fact remains that the owner of the tenth job pays the cost of estimating the other nine in which he has not the slightest interest. Through the adoption of the quantity system the bidders are relieved of the cost of preparing estimates, and the owner pays the cost of the estimate for his own job only.

One of the most certain, far-reaching, and beneficial effects of the quantity system will be the production by the architect of more accurate and intelligible drawings and specifications. The improvement must result from the full and frank co-operation between the architect and the quantity surveyor, in the preparation of drawings and specifications, and from them of the bill of quantities. As already shown, accurate quantities cannot be taken from deficient drawings and specifications. The quantity surveyor will apply to the architect for information on all points not made clear by the drawings and specifications. Is it possible to conceive of a more thorough check for accuracy and clearness? Conversely, with such co-operation, it must follow that the bill of quantities can be prepared with a far greater degree of accuracy than is now possible.

Each contract should include a clause providing that—the work comprehended in the agreement consists of the quantities of the various materials comprising the bill upon which the bid is based, worked in accordance with the requirements of the accompanying drawings and specifications.

Each contract should also include a clause providing for increased or decreased compensation to the contractor resulting from additions to, or deductions from, the original bill of quantities due to any cause or by reason of subsequent changes in the work, at the rate of the unit prices set forth or deducible from the bid, plus ten per cent. for additions, and at the rate of the unit prices set forth or deducible from the bid, less ten per cent. for deductions; also for priced bills of quantities on extra work involving the use of materials differing in character from any of those originally billed.

In other words, the basis of the contract should be so flexible that it may be extended to cover deficiencies or contracted to cover excesses in the original bill of quantities, and so that it may automatically adjust itself to provide for changes in the work, always upon a fair and equitable basis.

If the quantities constitute the basis of the contract, and the contract prices for the various classes of materials automatically adjust themselves to the changes in the quantity and the changes in the work, there can be no dispute between the architect and the contractor over extras and deductions—and there should be none.

Nevertheless, since extra work carries with it a pro rata increase in profit, it is reasonably certain that a great number of contractors will endeavor to establish claims for extra compensation on the basis of alleged deficiencies in the original bill of quantities. If all such allegations can be reduced to questions of fact, through the establishment of standard rules and units for the measurement of executed work, there will be little chance, unless the architect is extremely negligent, for the contractor to prove a claim for excess quantities if they do not exist. The establishment of such standards as a preliminary step to the adoption of the quantity system is essential to the system's successful operation. Every thousand common brick billed must mean the same number of cubic feet of wall to each and every bidder, to the quantity surveyor, and to the architect. The work of establishing such standards will be taken up by the Association of United States Quantity Surveyors through committees in each trade. The standards so established will be based upon the best and most equitable practice in each trade, with due regard for the distinctions now made between the various classes of work. A bill of quantities drawn upon the basis of such standard rules for measurement and classification will be entirely intelligible to the bidders, because it will recognize the same distinctions and classifications in the work that now govern them in pricing the various departments of work.

Estimating on bills of quantities will reduce competition between bidders to the sound basis of efficiency. In such competition the factors that would count would be the contractor's ability to buy at the lowest cost, his credit, rating, and capital, and the efficiency of his organization and methods in construction. The material man, who stands back of the contractor, would be fully justified in selling at minimum rates where there was no financial risk involved. The "wild-cat" contractor, the contractor without financial standing, and the inexperienced contractor would soon be eliminated. Under such competition they could no longer exist, for the work secured through taking a chance would net a loss.

The quantity system will impose upon the architect the necessity of following more precise and fairer methods in the matter of making estimates for payments. All payments will be computed upon the basis of units of materials worked, times the unit price fixed by the contract or deduced from the bid. The contractor will receive the exact amount of money to which he is entitled for the amount of work performed—no more, no less. The present method of making estimates for payments upon the basis of shrewd but "safe" guessing as to the value of the work performed, would necessarily be relegated to the past.

All those to whom the proposition has been made of establishing the quantity system have hailed it as being the solution of the one great problem in the field of building in this country, but they have also been pessimistic as to the ultimate success of the movement. However, if the architects of the country will get together and decide upon some method of procedure providing for the co-operation of the intelligent contractor, all obstacles will be overcome and there will be a greater measure of contentment in the lives of all; and that alone is well worth the effort.

Yours truly,
Sullivan W. Jones.*

An Opportunity for a Genius

Saskatoon, Sask., Feb. 10, 1914.
Editor Contract Record:

Without entering into a detailed discussion of your article relating to "skyscrapers," I may tell you that here in Saskatoon we are saved from architectural abortions of the kind by our by-laws, which limit the height of buildings in the business area to 120 feet. This is a wise and timely precaution. Experience teaches us that excess in any style or fashion becomes vulgarity, but unfortunately there are always to be found those who are prepared to risk the stigma of vulgarity in the pursuit of a certain amount of fame (or shall we say notoriety?). Architectural opinion varies as to the beauty or otherwise of the high building. Isolated examples would seem to indicate that here is an opportunity for a genius—some man whose name will become immortal by virtue of his founding a new school of architecture which shall make the skyscraper an object of admiration. General practice, however, has not been encouraging and the by-laws which have settled the question for the city of Saskatoon certainly have my approval.

Yours very truly,
T. Brammall Daniel.

The net profits of the Canada Cement Company for the year ending December 31st last were $1,536,432, an increase of $141,756. The net earnings, after all charges and preferred stock dividend had been discharged, were $409,217, equal to 3.03 on the common stock, against 2.10 in 1912 and 2.06 in 1911. Senator Edwards, the President, in his report, estimates that, with the completion of the Medicine Hat plant, the total capacity will be 12,000,000 barrels per annum, ample to meet all requirements for many years to come. The company anticipated better profits for 1913, but on account of construction work being seriously delayed by the non-delivery of materials purchased during the early part of the year, they did not derive any benefit from the improvement made in the plants until late in the year, and, in addition to this, construction work at the various mills interfered to some extent with their economical operation. These facts, together with the increased cost of coal, sacks and other materials, prevented the company from making any further reduction in the selling price of cement during the past year. It is their intention, however, to continue the policy of price reductions, and they anticipate that with construction work, except at Medicine Hat, practically completed, they will be able to obtain a decreased cost and effect a saving in distribution to the Western Provinces, which will enable them to make further reductions in the selling price of their product in the West. With a greatly increased capacity they are in a position to do a much larger business than heretofore and to distribute their products to all parts of the Dominion at less cost.

Trap-Rock Crushing Plant at Bruce Mines, Ont.

To prepare immense bodies of trap rock at Bruce Mines, Ont., 40 miles east of Sault Ste. Marie, for use in road construction a large crushing plant has been installed at that point by the Martins International Trap Rock Company. The plant, which is described by the Engineering Record, has a capacity of more than 500 cu. yd. per hour, and is laid out with a view to future enlargement.

Two 110-ton steam shovels, two large electrically operated churn drills and twenty-five 8-yd. steel automatic-dump quarry cars constitute the quarry equipment. The material is hauled from the quarry and dumped direct into a Superior jaw crusher with a 5 x 7-ft. receiving opening. Reduced by this crusher, which is the largest built, to about 10-ft. size, the material passes over a short grizzly, the fines falling on a 4 x 76-ft. pan conveyor and the oversize continuing to two No. 9 McCully crushers. The material from the McCully crushers is discharged to the same pan conveyor, which elevates the entire output and delivers it to a 7 x 18-ft. McCully stone screen. From this screen the fines are discharged upon a 4 x 116-ft. pan conveyor, the oversize going to two sets of 54 x 24-in. Superior rolls. The rolls in turn discharge into the same conveyor, which carries its load to a second 7 x 18-ft. screen. From this screen the larger sizes are delivered to storage piles by gravity and belt conveyors, the fines to a cross-conveyor which takes them to two 4x12-ft. double-deck screens, whence other conveyors take them to other storage piles. From the storage piles the material is loaded on vessels by belt conveyors in tunnels under the piles.

Storage is provided for approximately 80,000 cu. yd. There are two rows of storage piles, and under each row is a concrete tunnel with feeding hoppers in the roof. Each tunnel is provided with a 40-in. belt conveyor 330 ft. long, capable of loading stone at a rate of 750 tons per hour. Near the discharge end of each conveyor is installed a Merrick weightometer, which automatically weighs the material. With the system the largest vessels can be loaded within a few hours.

The layout is such that a duplicate plant can be installed at a later date, or the storage of the present plant can be increased to 120,000 cu. yd. by the addition of one concrete tunnel with loading conveyor and overhead distributing conveyors. The crushing machinery was furnished by the Power & Mining Machinery Company, of Cudahy, Wis.

Messrs. Burke, Horwood & White, Architects, Toronto, have just removed to new offices on the fifth floor of the new Ryrie Building at the corner of Yonge and Shuter streets, Toronto. It is interesting to note that the firm are the architects who designed the remodelling and enlargement of this building.

---

*Mr. Jones is a member of the firm of Messrs. Palmer, Hornbostel & Jones, architects, of New York and Montreal. This firm has designed many noteworthy buildings in the United States, among which may be mentioned the Carnegie Institute of Technology; the University of Pittsburg, and the Soldiers' Memorial at Pittsburg, Pa.; the Northwestern University at Evanston, Ill.; the New York State Education Building at Albany, and the City Hall Building at Oakland, Cal.

The New Waterworks for Port Alberni and Salmon Arm in British Columbia

INCIDENTAL to the installation of municipal systems in British Columbia, such as new waterworks, are constructional problems which are of particular interest and almost unique in their methods of solution. As an example we have the Port Alberni and Salmon Arm waterworks, which were completed last year and turned over to the respective municipalities by the Vancouver Wood Pipe & Tank Company, Limited.

The contract for the Port Alberni waterworks was awarded in September, 1912, and operations were commenced the same fall. The work was to have been completed in eight months, but delays in receiving steel for the banding of the continuous stave pipe occurred and it was not until August of 1913 that the plant was turned over to the city of Port Alberni. The contract was originally let to the Municipal Construction Company, as it was then called, and the price approximated $108,000. It is a municipally-owned enterprise and marks the development of the first port on the west coast of Vancouver Island, and one of the furthest west in Canada. Railway connection to Port Alberni from Victoria, via Nanaimo, has been completed by the C. P. R. for over a year past, and the Canadian Northern Pacific Railway is fast completing its system on Vancouver Island, which will also reach Port Alberni.

The main points of interest to be noted in the newly-completed waterworks system of Port Alberni are the intake dam of cribwork and rock filling, the supply main, 7¼ miles in length, and the distribution service in the city, comprising nearly five miles of six-inch mains, with adequate fire protection through numerous hydrants installed at principal points. The water supply, like most of the plants supplying towns and cities in British Columbia, is by gravity. Very few cities, so far, in the Pacific province, have not been able to provide themselves with water service of this type.

The intake dam of the Port Alberni system is about 200 feet long. It is erected on China Creek, the source of supply. To reach the dam and lay the pipe line on the route selected, a roadway had to be made for the entire distance, considerable difficulty being experienced. The whole ground was rather rough, and for the most part it was heavily timbered, trees six feet in diameter having to be cut out of the right-of-way. Heavy rock work was encountered in many places. Some idea of the magnitude of the task of even building this road may be gathered from the fact that 6,000 yards of rock and over 22,000 yards of earth had to be handled.

The roadway was brought to pipe line grade all the way, as the pipe was laid on the inner side next the bank, so that the covering could be done by simply excavating the slope and letting the earth down on the pipe after it was constructed. This made the work of construction all the easier, as it had not to be carried on in a deep trench. An important feature of the roadmaking and pipe-laying was providing for six inverted syphons. This was necessary because of the contour of the line, which crossed several deep ravines, almost amounting to canyons in one or two instances. The roadway had to be raised in places a height of 20 feet, to make it conform to the extreme curve plotted for the pipe. It required no less than 30,000 lineal feet of crib timber for this one item of the construction.

For the first 26,000 feet the pipe is sixteen inches in diameter, the continuous stave type of construction being adopted. Douglas fir, clear stock, well seasoned and carefully selected, was used for the staves, which were dressed to radial section of 1⅝ inches thickness from 2 x 4 stock. The slotting of the ends of the staves to hold a metal tongue, which keeps the staves in place in the pipe, is perhaps one of the most important features of continuous stave construction. It is one which certainly requires extreme care. To secure absolute uniformity in the interior of the tube, the Vancouver Wood Pipe & Tank Company have perfected and patented a machine which cuts the slot in the end of every stave with unvarying accuracy. The slot is cut

Waterworks system Port Alberni, B.C.—Dam and crib work.

parallel to the width of the stave and the metal tongue, which is two inches wide, is made long enough to project slightly past each edge of the stave and thus engage the edge of each adjoining stave as the pipe is drawn up by the bands. The banding of the pipe was with half-inch round steel, spaced an average distance of 2½ inches. Many curves had to be made in the pipe, owing to the contour. These were in addition to the inverted syphons, so that both lateral and vertical bends are demonstrated in this pipe line, which is an excellent example of the adaptability of the continuous stave type of wood pipe for a country such as that where it had to be laid.

For the remainder of the supply line to the borders of the city, steel pipe was used. Of this, 7,300 feet was 12-inch and 5,800 feet 10-inch diameter. The total elevation of the intake dam above sea level is 614 feet, which was too great a head for regular working pressure. Reducing pressure valves were therefore placed on the 12-inch and 10-inch steel pipe, and the pressure was brought down to an average of about 110 lbs. in the city.

Waterworks system Port Alberni, B.C.—A section of the pipe line, showing the heavily timbered and rocky country through which it was laid.

Wire-wound wood stave pipe was used for the 4 or 5 miles of six-inch distribution mains in the city. House services were connected up at the time these distribution mains were laid, the whole being under the direct supervision of the city engineer. Port Alberni now has every advantage to be derived from a complete modern water supply, and it has sufficient for a population of 20,000 people, which it will be some time in realizing, bright though its future is now, with railway service established and to come. A noteworthy point in the history of Port Alberni, and of the province, is that here was erected early in the sixties of last century, by Capt. Stamp of Boston, the first saw mill, in British Columbia. The mill has long since been removed, but a more modern one has taken its place.

Another water system installed in 1913 by the Vancouver Wood Pipe & Tank Company, was that of Salmon Arm, a thriving town in the interior of British Columbia, on the main line of the C. P. R. and on the shores of Shuswap Lake. Here a service was given by means of a main and distribution pipes of several miles in all. The supply was taken from Canoe Creek at a head of 700 feet, which was reduced by breaking into a 50,000 gallon tank, from which direct service through the city is given. To render it frost-proof, the tank was housed in an octagonal frame building, as the winter weather in that part of the interior is severe at times.

A large contract carried out successfully by the Municipal Construction Company, as this concern was formerly known, was that of installing over 55 miles of steel pipes in the waterworks system of Burnaby, one of the municipalities of Greater Vancouver. This work was completed just prior to the beginning of the Port Alberni contract in 1912. In 1910 and 1911, the same company successfully completed the installation of a 25-inch steel main, 74,000 feet in length, for the city of New Westminster. This was for a supply from a new dam built by the Vancouver Power Company at Coquitlam Lake, just east of Burrard Inlet, in the mountains, near Vancouver.

Mr. J. S. Reekie is President, Mr. W. Stocks, Vice-President and Mr. S. Reekie, Secretary-Treasurer of the Vancouver Wood Pipe & Tank Company, Limited. Mr. J. C. McKenzie was superintendent of construction on the Port Alberni contract and also acted in this capacity on several previous contracts. Mr. E. J. Cosens is superintendent of the factory, which is located in Vancouver City, as is also the company's office.

HOW the old C. P. R. bridge over the St. Lawrence river at Lachine, erected as a single track structure in 1885, has in the last two years been practically rebuilt as a double track bridge, without any interference with traffic, was narrated to the Canadian Society of Civil Engineers in a paper read by Mr. P. B. Motley. Two independent single track bridges were built and the old bridge removed in sections. While this was being done an average of 18 trains a day passed over the bridge during working hours. This was accomplished by cantilevering spans from the piers supporting the old bridge, by sinking pneumatic caissons, by employing floating barges, and transferring traffic from the old to the new spans as the latter were completed. In the old structure the entire weight of metal work was about 4,100 tons; in the new bridge 14,231 tons. The total quantity of masonry and concrete in the original piers and abutments was approximately 12,400 cubic yards. In the additions to the old piers and in the new piers there are 13,300 cubic yards. The number of rivets in the new bridge is approximately 3,500,000. The cost was slightly under $2,000,000.

A concrete hardening material now being introduced contains 95 per cent. iron dust or iron flour, which is mixed with cement for finishing the surface of concrete floors. From 15 to 25 lbs. of the material is mixed with 100 lbs. of the cement while dry, and one part of this mixture to two parts of sand makes the slush for the top coat, which varies from 1-2 to 1 in. in thickness. It is said to make a hard and durable floor, which is waterproof and not slippery. The hardening material is used also to make new concrete adhere to old concrete in repair work.

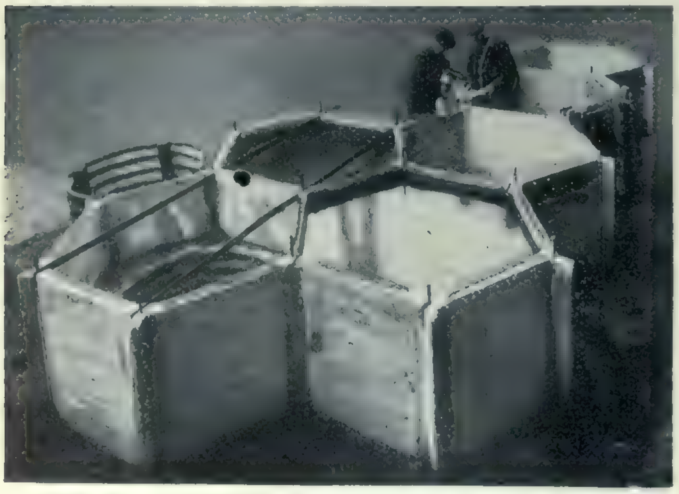
A New System of Reinforced Concrete

"Vibrocel"—Its Theory and Its Special Application to Subaqueous Work. Economy and General Efficiency of this Construction.

By J. E. Holdcroft, A.M. Can. Soc. C.E., Vancouver

THE special application of "Vibrocel" to subaqueous work being mentioned in the heading of this article, the question may arise in some minds, "Is there any need for a new system in this particular class of work?" A glance at the difficulties and the almost prohibitive expense connected with the construction of works of a permanent nature below the surface of the water in rivers, harbors and the like, immediately suggests an affirmative answer.

A new system is needed—one which will combine the advantages of massive solidity of construction, adequate reinforcement against extraordinary stresses, and moderate cost—one which will not require the construction of heavy false-work, costly both to build and to remove, or necessitate the use of the huge and expensive travelling cranes and other gear familiar to those who know the so-called "block system" of concrete construction in harbor improvements.



Vibrocel cells in the making, showing two-inch cell walls, with reinforcement, absolutely watertight; reinforced pillars and staples; bar reinforcement; and in cell on left hand method of strengthening outer cells of floating units of sea walls.

These requirements, almost Utopian (if such a use of the word is permissible) in their character, the inventors of the "Vibrocel" system claim to have met almost perfectly.

It is only a very few years since a new definition of a civil engineer appeared in one of our professional journals. It stated in words characteristic of the time: "An engineer is one who can do with one dollar what any fool can do with two." Rude as the expression seems, it is nevertheless very true, and it emphasizes the fact that economy and efficiency (neither of these alone, but both together) is the slogan of to-day, which alone justifies to the men of finance and commerce, our real employers, our existence as individual professional men and as a body of engineers. Any new thing, therefore, which tends towards increasing the efficiency or usefulness of a structure and towards decreasing its cost, whether first cost or up-keep, is worthy of careful consideration.

The coined word "Vibrocel" embodies the two main features in this system, viz., the vibration of the concrete and the cellular construction of the sections or units. Neither of these two features is new, but it is their combination which makes the cellular construction economically possible, while the carefully thought-out details eliminate to an almost unprecedented degree, that handling of heavy loads and the scaffolding which is such a costly item in most large structures.

Now, while, as stated before, vibration of concrete is not an unknown process, yet, so far as is known, no attempt has ever been made to vibrate concrete "in situ" previous to "Vibrocel" experiments. A comparison of the results of ramming and vibrating concrete will serve to point out the advantage of the latter process.

If a sample of fairly dry concrete be rammed in a form it will have a tendency to "bridge," like sand under similar conditions, transferring the weight of the rammer's blow to the side forms and tending to burst them. Even when a very small quantity of the mix is rammed at a time, the object of the ramming is partly defeated by the bridging action of the grains of aggregate themselves. It may be contended that this is only so in the case of so-called "dry" concrete, and that if the mix is made "sloppy" it is possible to secure the maximum density. But a moment's consideration will show that ramming or spading "sloppy" concrete does not consolidate it, but only serves to keep it in a state of emulsion. The result is that a much larger quantity of water than is required for the actual setting process is incorporated in the mass, which, when the superfluous water has finally evaporated, is left in a porous condition and is also liable to a considerable shrinkage. This shrinkage causes the surface of concrete walls or floors to be covered with a network of hair cracks into which water can penetrate.

The destructive effect of frost on such concrete is well known. It is true that these hair cracks, or at any rate the outward appearance of them, can be eliminated by various means to a greater or lesser extent, but they exist nevertheless, and serious damage is caused by them, as is shown by the fact (to take a single instance) that in Norway, concrete as a construction material for quays is being abandoned on account of the destructive effect of frost. Compare with this the results of vibration on concrete, whether a wet or comparatively dry mix. Consolidation is at once effected, the grains of sand and aggregate being brought into the closest possible contact, to such an extent that the superfluous water, with even some of the excess of cement, is forced to the surface, leaving only sufficient to fill the small percentage of voids in the closely compacted sand. By this means such a dense mass is obtained that further shrinkage is impossible, and the hardness and strength of the original stone is rivalled, if not surpassed.

The further results of vibration are so remarkable

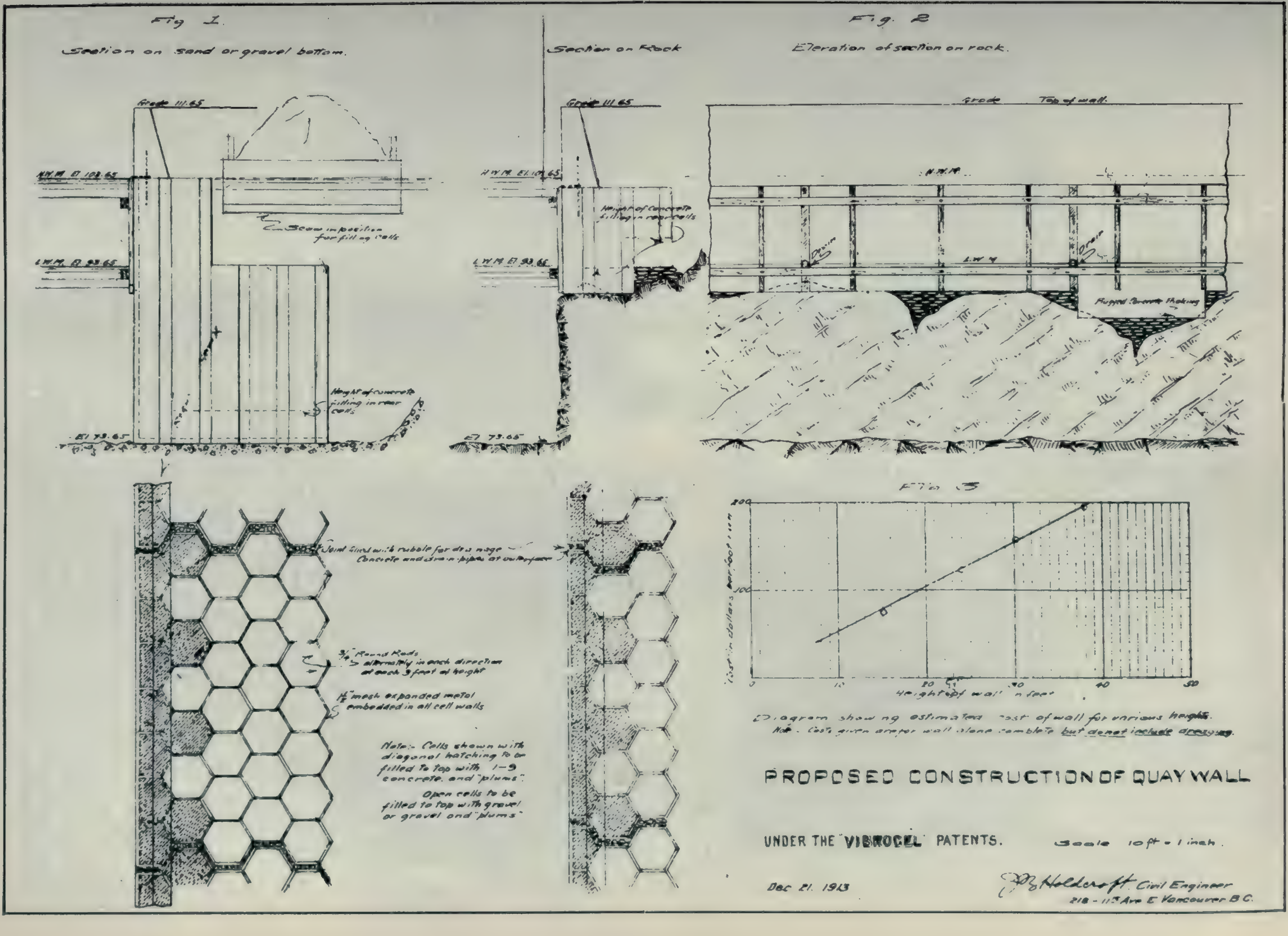


Fig 1.
Section on sand or gravel bottom.
Grade 111.65
H.W.M. El 103.65
L.W.M. El 93.65
Scow in position for filling cells
Height of concrete filling in rear cells
El 73.65
Section on Rock
Grade 111.65
H.W.M. El 103.65
L.W.M. El 93.65
Height of Concrete filling in rear cells
El 73.65
Fig. 2
Elevation of section on rock.
Grade
Top of wall.
H.W.M.
L.W.M.
Drain
Drain
Rugged Concrete Footing
Joint filled with rubble for drainage
Concrete and drain pipes at outer face
3/4" Round Rods alternately in each direction at each 3 feet of height
1/2" mesh expanded metal embedded in all cell walls
Note:- Cells shown with diagonal hatching to be filled to top with 1-9 concrete and "plums".
Open cells to be filled to top with gravel or gravel and "plums"
Fig. 3
200
100
Cost in dollars per foot run
0
10
20
30
40
50
Height of wall in feet

Diagram showing estimated cost of wall for various heights.
Note. - Costs given are for wall alone complete but do not include dredging.

PROPOSED CONSTRUCTION OF QUAY WALL

UNDER THE "VIBROCEL" PATENTS. Scale 10 ft = 1 inch.

Dec 21. 1913

Holdcroft Civil Engineer
218 - 11th Ave E Vancouver B.C.

that we would hesitate to mention them, were they based on theory alone, and not, as is the case, on personal observation and reliable tests. For instance, vibrated concrete is not only water-proof in the ordinary acceptance of the term, but absolutely damp-proof. A vessel with sides only one-half inch thick stands in the offices of the Vibrocel Company in London. Not only does the vessel hold water, but it has stood full for months without a trace of dampness appearing on the outer surface. Another instance will suffice. A cell was built of vibrated concrete with walls two inches thick and three feet high, the diameter being seven feet. Within this cell another one with similar walls but of five feet diameter, was floated, sufficient water being put in to rise almost to the brim of the outer cell. In spite of the fact that the inner cell displaces nearly a ton of water, and that it has been floating so since May or June, 1913, no trace of dampness has appeared on the walls or bottom of the outer cell and only very slightly in one corner of the inner one. Little more need be said regarding the advantages of vibration than to record, in passing, the results of certain tests made by the well-known testing engineers, Messrs. David Kirkaldy & Sons. These tests bring out the surprising fact that vibrated concrete has about double the compressive strength of concrete which has been rammed in the ordinary way.

Description	Weight	Dimensions	Base Area	Total stress	Stress per sq. in.		Remarks
	Cube of Concrete rammed in ordinary manner						Mixture 1½pts. granite
Mark 8.2.0 No. 1	16.78	5.99x6.00x5.95	35.70	80150	2245		chippings (⅜" mesh)
	Cube of Concrete vibrated						1½ pts. sand. 1 pt. cement
Mark 8.2.0 No. 2	17.74	5.92x6.00x5.99	35.94	161800	4502		Age—6 weeks Tests made April 20/10
R.	17.05	6.14x6.01x5.99	36.00	71400	1983	1810	Mixture 2 pts. sand from Thames ballast (⅜" mesh)
Rammed R.	16.11	6.19x6.01x6.00	36.06	53650	1488		1 pt. fine sand. 1 pt. cement
R.	17.22	6.14x6.02x6.01	36.18	70920	1960		Age—46 days, tests made March 27/13
X.	18.11	6.06x6.00x6.00	36.00	131900	3747	3502	
"Vibrated" X.	17.83	6.01x6.01x5.99	36.00	123900	3442		
X.	18.00	6.08x6.00x6.00	36.00	119400	3317		

These tests speak for themselves, and it only remains to point out that the substitution of vibration for ramming or spading solves the problem of placing concrete in narrow forms among complicated reinforcement. There is not the slightest risk of displacing the steel, and a better adhesion is obtained.

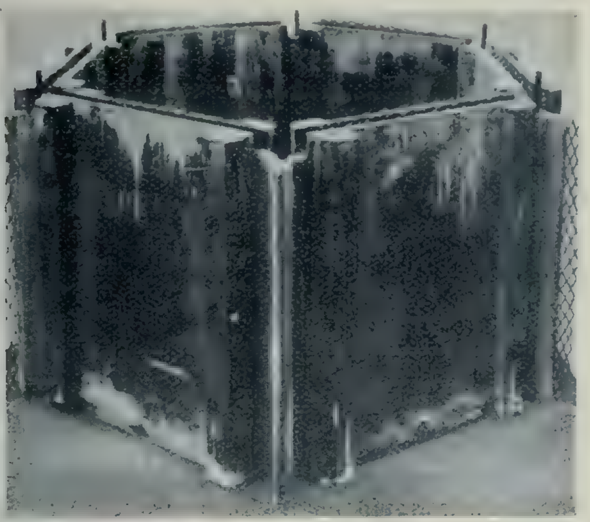
Having now explained the advantages of vibrating concrete, I will proceed with a description of the Vibrocel cellular system, which is made economically possible by the vibrating process. To quote from one of the Vibrocel Company's publications (to which we are also indebted for the records of tests and other data): "The cellular construction is advocated for the reason that it can be shown that it is the cheapest possible way of making cyclopean masses of concrete in almost unlimited size and strength for various purposes, the cost of which, carried out by the present method of block building is in many cases too great to allow the required work to be undertaken. The hexagonal form of cell has been chosen, this, as is well known, being the strongest. It would be tedious to go into an analysis of the stresses on this form, as well as unnecessary for our present purpose, but it can be shown that when a hexagonal cell or series of cells of that form is subjected to external pressure, there are no tensile stresses—all the cell walls are in compression. This is a point of some importance, as, when using vibrated concrete, it is practicable to build reinforced cell walls as thin as 2 inches, the steel, while being theoretically unnecessary, firmly tying together the whole series of cells; in other words, as much compressive strength is developed in a wall of vibrated concrete only 2 inches thick as would be obtained in a wall 4 inches in thickness built of rammed concrete. Thus there is a saving of fifty per cent. in the amount of rich concrete used for cell building simply by the use of vibration."

The economy of the method may now be seen. It is possible to build up, as a series of hollow cells, a complete shell of the proposed structure, using for the thin cell walls a rather rich, fine-grained concrete. These walls carry a continuous reinforcement of expanded metal throughout the structure and, in addition, steel bars are embedded in the cells, forming a series of triangles with them and extending to the outer walls. These hollow cells are then filled with a lean mixture of concrete containing plums, or in some parts of the structure gravel alone may be used, the cell walls supplying all strength necessary. The coarse, cheap material is thus in a proportion of about 10 to 1 of the rich reinforced concrete. Thus we have weight and solidity, and at the same time continuous steel reinforcement throughout the mass—a very desirable combination, especially in subaqueous work.

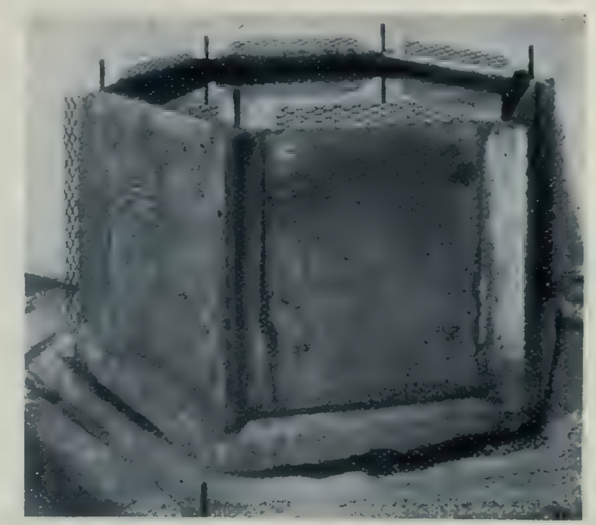
Before going on to describe the construction methods used, it will be as well to mention at once the features of this system, viz., the fact that the hollow cellular construction of waterproof concrete gives the builder power to erect his structure in large sections (minus the filling), afloat in a sheltered position, or near his base of supplies, then to tow them out to positions where they can be sunk instantaneously by blowing out the cell bottoms with embedded cartridges after the section has been lowered to within a foot or two of the previously prepared bottom, by admitting water.

It would be impossible within the limits of an article like this to go fully into the actual details of the operation briefly described above. Enough has been said to show that it is not only possible but practicable to build bridge piers, quay walls, docks, etc., without the usual expenditure for coffer-dams, temporary piers or expensive form work, and also without any heavy machinery whatever, save that required for dredging, which would be the same in any system of construction.

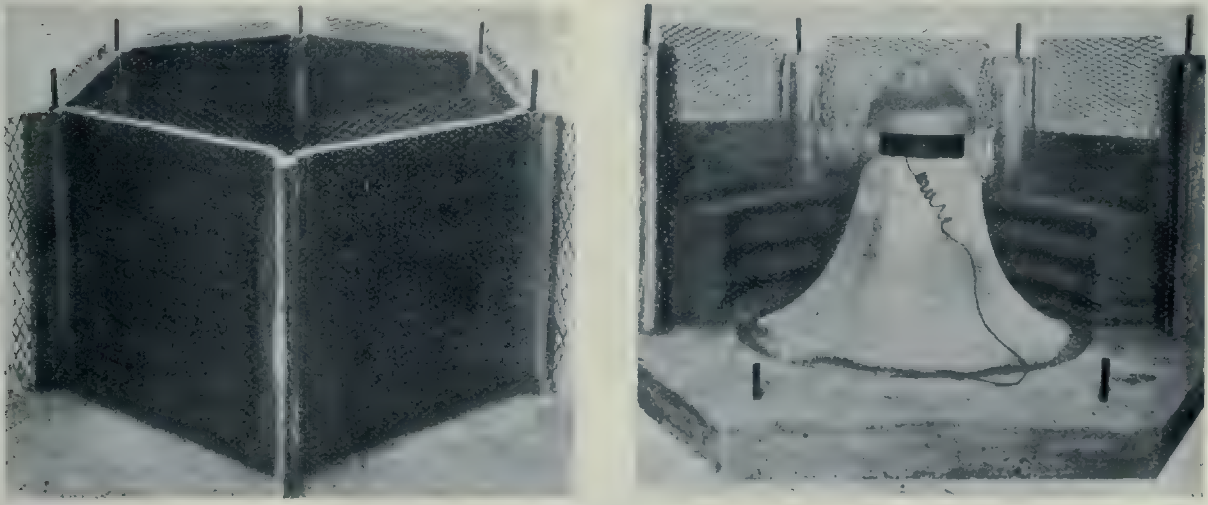
Before closing, a few words as to constructional details and costs will be of interest. Quoting once more from the publication referred to: "The construction generally is commenced by forming a concrete floor with upstanding dowels at the points where the walls forming the cells unite. On these dowels are placed pillars 3 feet high, made of vibrated concrete, each carrying 3 wings of reinforcement which overlap with the wings of the adjoining pillars and are embedded in the walls. To every pair of pillars so placed are bolted wooden shutters (or forms) forming the moulds in which the concrete walls, 3 feet high, are cast, embedding the contained reinforcement. During the operation of filling the space between the shutters with concrete, the patent pneumatic vibrators (hammers) are applied to the shuttering. The reinforcement before mentioned stands up a few inches above the tops of the walls, and will be included in the next tier of cells, also 3 feet high, making the reinforced concrete walls and pillars continuous throughout the structure. Dowels are placed in the tops of the pillars, and any desired height can be obtained by a repetition of the foregoing process, carried out in successive tiers of 3 feet at a time, resulting in continuous walls of concrete reinforced from bottom to top of the structure. In all this work no scaffolding whatever is required, the whole extent of the work being accessible by means of loose planks laid upon supports extending above the top of the shuttering.



Shutters in position ready for admission of concrete and its subsequent vibration.



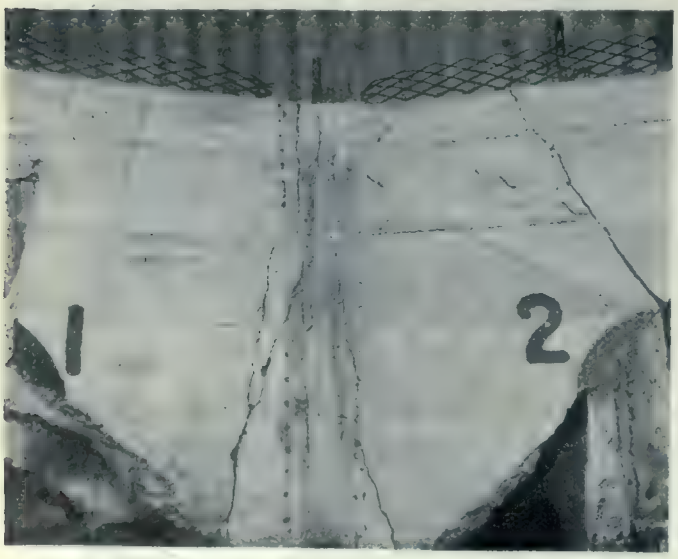
Cell filled with water to demonstrate its non-porous character.



On the left—shuttering removed after filling with concrete, and vibration; on the right, method of construction of bottom of cell of floating unit of sea wall, with cartridge chamber and electric cable for blowing out bottoms of cells and instantaneously sinking the unit.

No heavy machinery is necessary, and no single part of the work is too heavy for a couple of men to deal with. Among the many remarkable results of vibrating concrete "in situ" is the fact that, vibrated, the joint between old and new concrete is absolutely homogeneous. This latter statement, while given incidentally, is a very important one, and is well borne out by actual experiment. The reader will now be enquiring as to the cost of this method as compared with others. There are several factors which tend to reduce the cost. For example: (1) Roughly speaking 90 per cent. of the mass is of cheap, lean concrete, (2) No complicated form work is required, the forms used being simple square sections which can be used repeatedly. (3) The work is a continuous repetition of the same details, thus conducing to constantly increasing speed and cheapness of production. (3) As stated before, no heavy machinery or scaffolding is required. (5) No cofferdam or pumping is required, the cells being filled, after placing in position, with bagged concrete or by tremies. An estimate made by the Vibrocel Company, based on English prices, and including profit and royalties, places the cost at 25/- a cubic yard, which applied to our western prices would work out at about $9.00 a cubic yard—this, for completed work, including everything but excavation or dredging. Where gravel filling can be substituted for concrete in some of the cell sections, the cost can be further greatly reduced, sometimes working out as low as $5.00 to $6.00 a cubic yard, though it is only fair to say that in these cases there is a larger cross-section than would be used by ordinary methods. Making all allowances, however, one feels safe in saying that a saving of 25 per cent., more or less, can easily be effected on the general run of works of this class, where permanent and solid construction is required—each problem, of course, being made a separate study and designed for the maximum economy.

It will be of interest to add that this system has been adopted by the Bombay Government for a large reclamation project in a location where the wall will be exposed to the full sweep of the Indian Ocean. Another instance of special interest, from the point of view of cost, is a coal dock in the Cape Verde Islands. In this case the owners of the property had only a certain amout of money at their disposal for construction purposes, and on account of all tenders being of a greater amount than this, had almost found it necessary to abandon the project when the Vibrocel method was proposed and found to come well within the figure set. The estimated cost for this latter work is something like 50c a square foot, a remarkably low price for solid construction—due in part, probably to the cheapness of labor in the Islands. The attached drawing with diagram of estimated cost gives a good idea of the cost of one class of work under Western Canadian conditions. In other classes, such as dock or pier construction, it is probable that the reduction in cost over other systems would be even greater.



Cell burst by jacks, showing that vibrated the joint between the old and new concrete is absolutely homogeneous and that the lines of fracture nowhere coincide with the joints between the cell walls and pillar.

Digging Trenches and Holes in Frozen Ground

IN northern Minnesota, where the earth freezes to a depth of from 4 ft. to 5 ft. in winter and where consequently the cost of digging holes is high, the following expedient is used to keep down costs. When the top of the hole has been picked out to a depth of 6 ins. or more, a tin cup full of gasoline or coal oil is poured into the hole and lighted. The digging is then continued, the burning oil thawing the earth, and from time to time more oil is added. It is said that with the help of about a gallon of oil per hole, the cost of digging can be reduced approximately 15 per cent.

At the last annual meeting of the Iowa Engineering Society, Mr. Charles P. Chase described the use of lime for thawing frozen earth preparatory to trenching. The ground was frozen to a depth of 4 ft., so that it could not be excavated with a trench machine. Lime was spread upon the ground along the line of the proposed trench and to its full width. The lime was broken into small pieces and covered with manure or straw. Hot water was then poured on to slack the lime and liberate the heat that thawed the ground sufficiently to enable the trench machine to dig it.

Steam jets have been successfully used for similar purposes. For example, in "Engineering News" for April 13, 1899, a description was given of a method used for thawing frozen ground in order to dig holes for electric light poles, from which the following information is abstracted.

A vertical jet pipe was connected by a tee to a horizontal pipe 24 in. long, capped at one end and connected at the other by nipples and four elbows with a pipe leading to the boiler of a traction engine. The nipples and elbows were provided to allow the necessary play for handling the appliance. To protect the workmen from the steam and to enable them to manipulate the jet pipe, two wooden handles 2 x 4 ins. in section and 10 ft. long were connected by stirrups to the two ends of the short horizontal pipe.

This jet pipe was forced down by two men pressing on the handles; as the earth thawed out, the steam carried the particles out alongside the pipe; and as the depth increased more steam would be condensed in the borehole until finally no steam escaped and the outflow was liquid mud. This outfit, which was invented by Mr. James W. Pearl, of Decatur, Mich., would thaw out about 30 holes for electric light poles in a day of ten hours.

In "Methods and Costs of Gravel and Placer Mining in Alaska," by C. W. Purington (U. S. Geol. Survey Bul. No. 263, 1905), various methods of thawing gravel for mining purposes were described substantially as follows:

According to experience in one district the efficiency of a good fire in creek ground was as follows: A fire taking three-fifths of a cord of wood (at $12 a cord) is built against the face of the bank. The pile of wood is 18 ins. wide, 2 ft. high and 25 ft. long. Stones are laid up over the pile and a space is left to light the fire. The fire is lighted at 5 p.m. and left to burn until 8 a.m. the next day. The stones, which quickly get hot, are regarded as most efficient in thawing. On a 4 ft. thickness of pay gravel this amount of fire will thaw in the time specified from 5 to 6 cu. yds. This is at the rate of 9.2 cu. yds. thawed per cord of wood, which is considerably less efficient than the method of thawing with steam. Time, delays and awkwardness of the method, moreover, make wood fire thawing the most expensive that can be adopted. The figures per foot for shaft sinking range from $3.16 to $7.50 in taking gravel from prospect shafts.

The direct application of jets of dry steam to the gravel bank through the agency of driven pipes has been found to be the most efficient method in general practice for thawing frozen gravel. The amount of moisture contained in steam can be judged by the color of a jet of steam issuing from a small brass petcock. If it is transparent or whitish near the orifice it contains less than 2 per cent. of moisture. If pure white the moisture is above 2 per cent. A ¾-in. steam hose is run from the boiler to the bank, where it ends in a manifold to which several ½-in. hose lines can be coupled. Each of these small lines ends in a hollow bar about 5 ft. long with a tool steel point which is driven into the gravel and enables the jet of steam to penetrate far into the interior of the frozen mass.

In creek claims exceeding 15 ft. in depth, where solidly frozen ground occurs, the method of drifting with the use of the steam point is as follows:

A 20 h.p. boiler, capable of running 10 steam points, is put on the ground, and frequently one or two extra long points are provided for sinking holes. These long points, from 10 to 12 ft. in length, are not so strongly made as the 5-ft. points used in the drifting operations. In some cases pieces of ½-in. hydraulic pipe are used. The point is set up on the ground and steam or hot water is turned on. The time for sinking a hole by this method to bedrock is from 24 to 48 hours. If large flat stones are encountered in the gravel it is sometimes advisable to use strong, specially made points to prevent breaking. The average radius of a vertical shaft thus thawed by a single point is 2 ft. and the hole when cleaned out has a cylindrical or tube shape.

On some of the work the 5 ft. points are used in batteries of four points each. A mallet is used to drive the points into the bank. where they are left from 10 to 14 hours. Each point thaws a block of gravel averaging 6 ft. into the bank, 18 ins. on each side of the bank and 4 ft. high. The use of hot water turned into the hose for starting the points is considered good practice. The points must be driven carefully and slowly, and for ten points distributed along a face the average time needed is from one to three hours. The amount of steam required for each point has been found to vary in amount from 1 to 2 boiler horse-power. The amount of gravel which a point will thaw appears to vary with the length of the point, and this is regulated somewhat by the character of the gravel. The 5-ft. point has been found to be the most economical.

A typical case illustrating the efficiency of the points is the following: Points of Dawson manufacture, 5 ft. long, costing $15 laid down, were used in manifolds of four. They were put in at distances of from 2 ft. 6 ins. to 3 ft. apart, and were started with hot water. It took three hours to drive them in. A 12 h.p. boiler supplied the steam for ten points, three-fourths of a cord of wood being burned while the thawing was done. In twelve hours the ten points thawed a block of gravel 30 ft. in length by 5 ft. high, 6 ft. into the bank or a total of 33.3 cu. yds. This is at the rate of 3.3 cu. yds. per point and 44.4 cu. yds. per cord of wood.—Engineering and Contracting.

Ten Rules to Eliminate Building Failures

FAILURES happen at times in all lines of construction work, but it is to be regretted that whenever concrete is involved in any way, the disaster becomes "another concrete failure." Steel, brick and timber construction fails, too, but, as for instance, in the Quebec bridge failure, it was not a "steel failure," but a "bridge failure," a failure in design or workmanship. Concrete, however, is in the spot light, and must carry the brunt of blame, as well as receive praise and admiration.

Failures can be, and should be, avoided, by proper, intelligent precautions and workman-like methods. The following 10 rules, by W. P. Anderson, are a valuable guide to better practice:

1.—All buildings should be designed by a competent engineer and erected by contractors with special experience in this line of work.

2.—In winter weather the sand and stone aggregate entering into concrete should be heated before concreting. One good method of doing this is to blow steam into the pile of material.

3.—The water used in mixing should be warm but not hot. The temperature of the water should not be over 130 deg. Water above this temperature is harmful to the cement.

4.—Avoid concreting when the temperature is below 25 deg. or when there is any likelihood of a sudden drop in temperature.

5.—After concreting in cold weather cover the floors with straw.

6.—Keep salamanders going under the concrete work and enclose all openings around building so that the heat can be confined.

7.—Watch the shoring carefully during concreting, as occasionally an imperfect shore due to a knot or some other cause may be used which should be replaced immediately.

8.—Leave all shoring until concrete has thoroughly set. Form work may be removed much sooner than the shores and when this is done, care should be taken to wreck only a small section at one time before reshoring. Where the weather is apt to be below freezing for several weeks at a time in the winter it is better to leave the beam bottoms under the beams so that the shores under the beams do not have to be removed at all when taking down the slab panels. The shores should never be removed until the concrete is so hard that it is impossible to drive a 10-d. nail into the concrete and there should be at least 30 das. when the temperature of the concrete is above 45 deg. before the shores are removed. This temperature, of course, can be obtained artificially if necessary.

9.—In re-shoring, care should be taken to put a cap at least 2 ft. long and 4 in. wide on top of the shore to distribute the load, and in the case of concrete and tile or similar construction, this cap should be so placed that it bears on one or more ribs and in no case should it bear entirely on the tile, for, in the latter case, the tile will crush and cause the supporting floor to fall.

10.—Care should be taken to place a sill under all shores and especially in case of a tile and joist or similar construction where thin concrete members occur, these sills should be so placed that they will distribute the load over the joints in a tile and joist construction.

An additional suggestion which Mr. Anderson makes is as follows:

No cement should be used until it has been tested for soundness and fineness and for tensile strength at 1 da., 7 das. and 28 das.—Concrete-Cement Age.

One of the numerous methods by which concrete blocks can be given a finished appearance is surfacing them with a sand blast. The surface cement is worn away by the sand; the block is given a polish, and the broken stone, of which it is partly composed, appears, thus giving the block something the appearance of a polished limestone breccia. A glance at any pavement, from which the surface cement has been worn away, will serve to convey a very rough idea of the appearance a sand-polished cement block presents. If the mixture has been made with proper care, the block can be given quite an effective-looking surface, and, so far as appearances go, it is infinitely superior to the ordinary concrete block. It's one disadvantage lies in the fact that surfacing by sand renders the block more liable to erosion.

Suggested Designs for Sewage Treatment Plants for Residences and Small Institutions

THE information given in this article is abstracted by Engineering and Contracting from a paper by Mr. Paul Hansen, Engineer of the Illinois State Water Survey. The article gives data on the cost of plumbing a house, on the design and operation of simple septic tanks, of a modified Imhoff tank adapted to the use of a household of ten persons, of a subsoil irrigation system, an intermittent sand filtration plant to handle the sewage from a household containing twenty-five persons, and a double contact filtration plant.

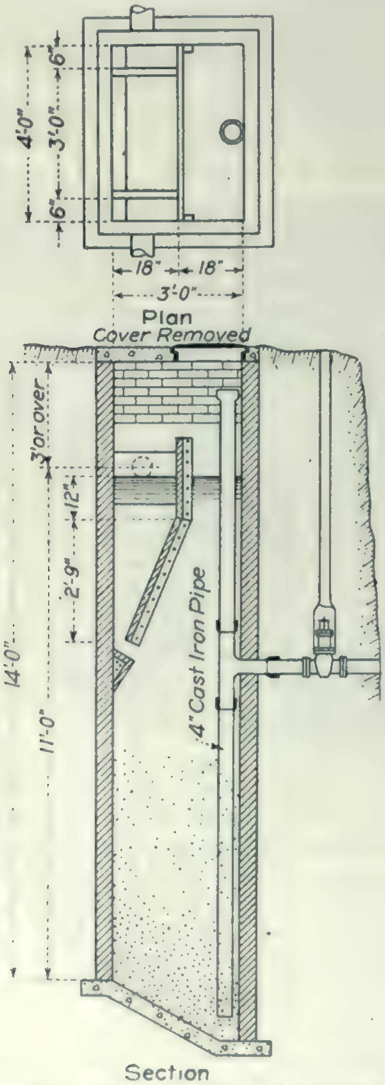


Fig. 1—Suggested design of modified Imhoff sewage tank for household of ten persons.

Cost of Plumbing.—An approximate estimate of the cost of plumbing a house is given in the following tabulation, the figures given relating to a two-storey house with basement:

Soil pipe with necessary Y and T connections	$15.00 to $30.00
Two-set tubs for laundry	20.00 to 60.00
Kitchen sink with drain board	7.50 to 30.00
Bath tub	20.00 to 200.00
Wash basin for bath room	7.50 to 40.00
Closet	17.50 to 75.00
Necessary piping and faucets for hot and cold water, including hot water boiler	20.00 to 40.00

Looking at the matter in another way, complete house plumbing including bath tub, sink and laundry tubs of wood and zinc, wash basin of enameled iron, water closet of porcelain may be installed for $200. Complete house plumbing including closet, wash basin and sink of porcelain and bath tub and laundry tub of enameled iron may be installed for $300. The first represents cheap and somewhat flimsy construction; the latter first class and substantial construction.

Simple Septic Tank.—The simplest form of treatment device that may be used for a single house comprises merely a tank, capable of holding the sewage produced in a period of 24 hours or longer. Mr. Hansen suggests a tank of the following dimensions, to cost approximately $30 with concrete roof and floor and brick walls: Inside plan, 2 x 8 ft.; depth of tank, 6 ft.; depth of sewage, 3 ft. 10 ins.; simple wooden baffle, 1 ft. 6 ins. from inlet, extending 12 ins. into sewage; lower end of 6-in. outlet tile, a 90 deg. bend, submerged 18 ins.; the tank bottom slopes to the center, and the sludge is withdrawn from a sump through an outlet by opening a shear valve. The costs given in this article are relative figures, especially applicable to average Illinois conditions.

The effluent from a tank of this character contains no coarse solids, is likely to be dark in appearance and upon close observation will be found to carry finely divided suspended particles. It may be discharged into a perennial stream of moderate size without producing objectionable conditions, but where no such stream is available some other method must be utilized. In a sandy or gravelly soil the liquid may best be disposed of by permitting it to flow into a system of open jointed tile drains placed at 1 ft. to 18 ins. below the surface of the ground. The tile drain may be made up of a 4-in. farm drain and should have a length of about 100 ft. for every member of the household. The character of soil may materially vary the amount of tile necessary. To get the best results the liquid should be applied to the tiles in the form of a dose discharged rapidly from a syphon within a few minutes once every 12 or 24 hours. This can be accomplished by building in conjunction with the tank a

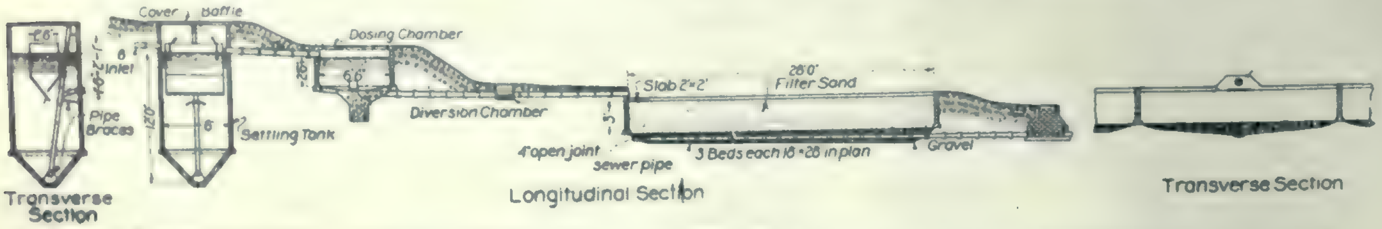


Fig. 2—Sectional elevations of a suggested intermittent sand filtration plant, with preliminary sedimentation, for treating sewage from household or institution of 25 persons.

small dosing chamber equipped with an automatic discharge syphon. Syphons are subject to derangements and may be omitted in favor of a more liberal use of tile. An arrangement for a sub-surface system of tile drains following passage through a septic tank is suggested by Mr. Hansen as follows:

Septic Tank, Dosing Chamber and Subsoil Irrigation

The septic tank is 2 x 6 ft. in plan and carries a depth of sewage of 4 ft. Its details are similar to those described above. The dosing chamber immediately adjoins the septic tank and is provided with an automatic siphon. After leaving the siphon the effluent passes into a system of drain tiles consisting of distribution and collector tiles, the former being from 12 to 18 ins. below the surface and the latter 1 ft. lower still and 5 ft. to one side of the distributor. The collector pipes may generally be omitted. Where the soil is of a finely divided character and capable of absorbing large quantities of moisture as is characteristic of most of the glacial drift the same system may be utilized, but can be relied upon adequately to take care of the sewage only during periods of small rainfall. This, however, often proves to be all that is needed for in wet weather the sewage may be discharged directly into a stream which will then have flow enough to provide the dilution necessary for inoffensive oxidation. Sufficient dilution may even obtain within the drain tile itself. It thus sometimes happens that the discharge of the effluent into the upper end of an existing long tile drain accomplishes all that is required, for in dry seasons the sewage will soak into the ground, while in wet seasons it will be carried to the outlet of the drain along with a sufficient quantity of water to render the liquid inoffensive.

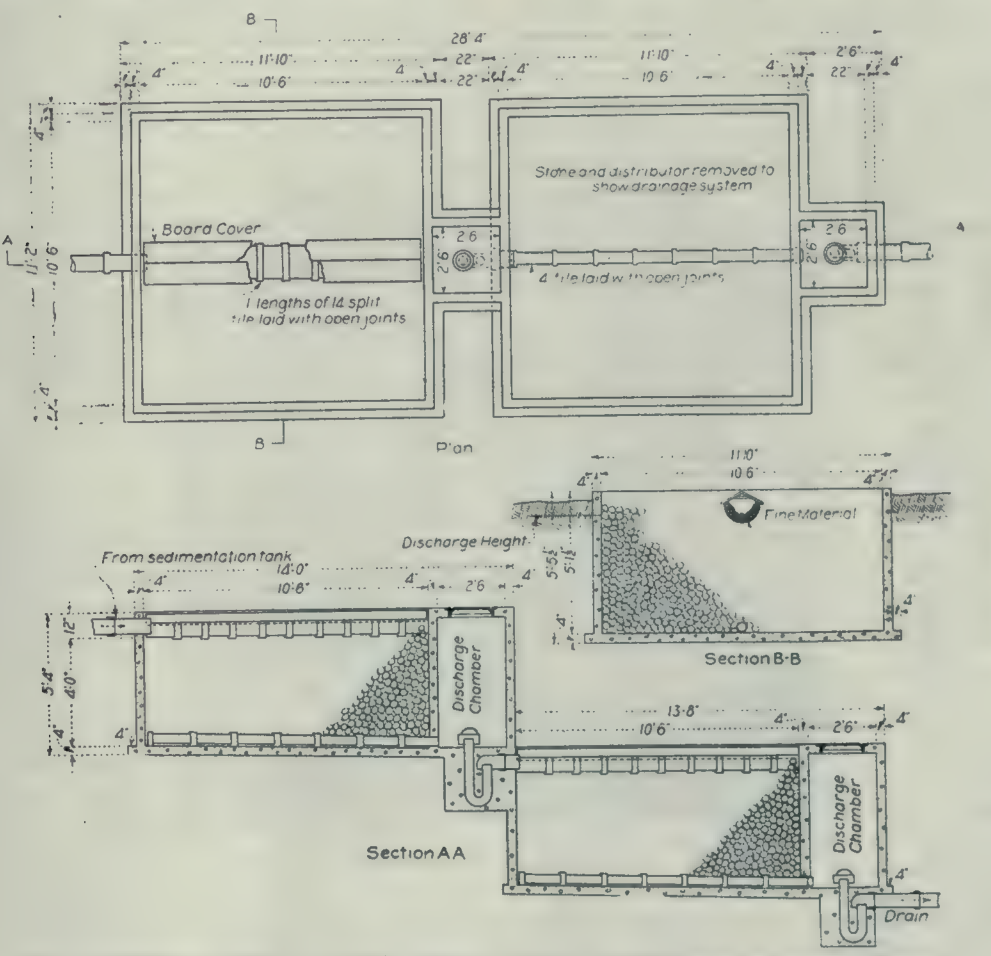


Fig. 3—Suggested design for double contact sewage treatment plant for large residences, country clubs or small institutions.

In certain forms of clayey soil any attempt to cause the sewage to soak into the ground will prove futile, but this difficulty may be overcome by artificially placing beds of sandy or gravelly material about the tile. When this is done it is necessary to place sub-drains for carrying off the more or less purified liquid after it has passed through sand or gravel. This arrangement constitutes the principle of a well-known proprietary device for sewage treatment and can be counted upon to produce satisfactory results as long as a sufficient quantity of porous material is used. For large installations, however, it would prove costly and uneconomical.

It is difficult to lay down any hard and fast rules relative to the design and arrangement of subsurface sewage disposal systems. The proper length of drain tile, the necessity of collector drains and the desirability of surrounding the drains with porous material must under many conditions be determined by the method of cut and dry. Where the system is applicable, however, it is certainly the simplest, least offensive and easiest to maintain.

Modified Imhoff Tank for Residential Service

With certain forms of secondary sewage treatment devices, and often where sewage is to be discharged into a watercourse it is desirable to maintain the sewage in as fresh a condition as possible; that is to say, it is desirable to maintain the oxygen content of the sewage. To accomplish this Mr. Hansen suggests a modification of the Imhoff tank as shown in Fig. 1 herewith. As will be noted the tank utilizes a small compartment for sedimentation purposes and a lower compartment for the digestion of the solid matters. The solid matters which are settled out in the upper compartments gain access to the lower compartments through a narrow slot so trapped that the liquids in the two compartments may not readily intermingle. The sedimentation chamber must be made very much larger than is customary in connection with municipal sewage treatment works for the reason that the very uneven rate of sewage flow from an individual residence would subject the sedimentation compartment to violent disturbances. For this reason an average period of five to six hours sedimentation should be provided.

This tank has an advantage in that the sludge or solid matter is thoroughly digested and may periodically be discharged into some nearby depression without giving rise to objectionable odors. When dry it has the consistency of rich loamy earth and may advantageously be spread on lawns and gardens. The modification of the Imhoff tank here shown is adapted to the use of a household of ten persons. The cost of such a tank would be about $60.

Intermittent Sand Filtration.—On large country estates or for isolated institutions such as alms houses, asylums, sanatoria, etc., perhaps the most economical and highly efficient system is so-called intermittent sand filtration. Figure 2 shows an intermittent sand filtration plant that will adequately care for the sewage of about 25 persons (generally they should not be built for populations of less than 25). The plant comprises also an Imhoff tank and a dosing chamber. The filters consist of a bed of sand 3 ft. in thickness, resting upon a carefully constructed under drain system of drain tile and a graded gravel. The total area of the installation is figured on the basis of one acre for every 750 persons tributary to the sewers. For a household of 25 persons there would be required 0.033 acres, or about 1,500 sq. ft. The sewage is applied to the filters intermittently and this is accomplished by a dosing chamber which is of such capacity that a single dose will cover one filter bed to a depth of 2 ins. The filter area should be divided into at least two beds, but preferably three. The latter arrangement permits one bed to be out of service for cleaning or repairs or for a protracted resting period without serious reduction in filter area and without interfering with the proper operation of other beds. The automatic dosing apparatus is so arranged that it will automatically discharge upon first one bed and the other and valve arrangements are such that any two beds may be maintained in service.

Intermittent sand filters will not operate without attention, and they should be visited at least once every few days to see that all parts are in proper working order and to keep the sand beds free from weeds. At greater intervals, perhaps once per month, it becomes necessary to take or scrape the sand lightly so as to break up the surface of the mat formed by the solid matter in the sewage, but with proper care this process should result in but very slight loss of sand. During the winter in cold climates it is necessary to furrow or mound sand beds in such a way as to cause the formation of a sheet of ice resting upon the top of the furrows. This will effectively prevent the freezing of the sewage as it passes along the troughs of the furrows underneath. The automatic dosing apparatus requires attention as already noted, but with a well settled sewage and siphons of reliable make derangements will be infrequent.

Double Contact Beds.—A somewhat more extensive method of sewage treatment and one which is especially adaptable to very large farm houses, country clubs and institutions and for use in locations where the production of odors is not permissible is treatment in so-called contact beds. An installation comprising double contact beds is shown in Fig. 3. It is assumed that the contact treatment will be preceded by sedimentation. The contact beds are water-tight basins filled with gravel, broken stone, hard burned cinders, broken brick or any other material which presents a fairly rough surface and which is not easily disintegrated. The size of the material should not average less than ½ in. in diameter or be greater than 1½ ins. in diameter. Means are provided for permitting the sewage to flow into this bed and to fill the interstices of the material which it contains where it may remain in contact for a definite period of time. The bed is emptied and the period of contact is regulated by means of a time controlled siphon. In the design as shown in Fig. 3 the effluent from the first contact bed passes into another contact bed of exactly similar construction. Upon emerging from the second contact bed the liquid will be fairly clear in appearance and will have no offensive odor, thus rendering it suitable for discharge into a small watercourse. For the purpose of minimizing odors a specially constructed inlet arrangement to the bed is provided which prevents the sewage from being exposed to the atmosphere. The device consists simply of short half tile 14 to 18 ins. in diameter and laid with large open joints. Within the invert of this half tile is placed fine broken stone or gravel and over the top is placed a readily removable roof. The device also has another advantage in that it localizes all clogging in the fine material within the half tile. When this becomes clogged so that it will not readily permit the entrance of the sewage into the bed it may be easily removed and replaced with new material.

Reinforcing Cast-Iron with Concrete

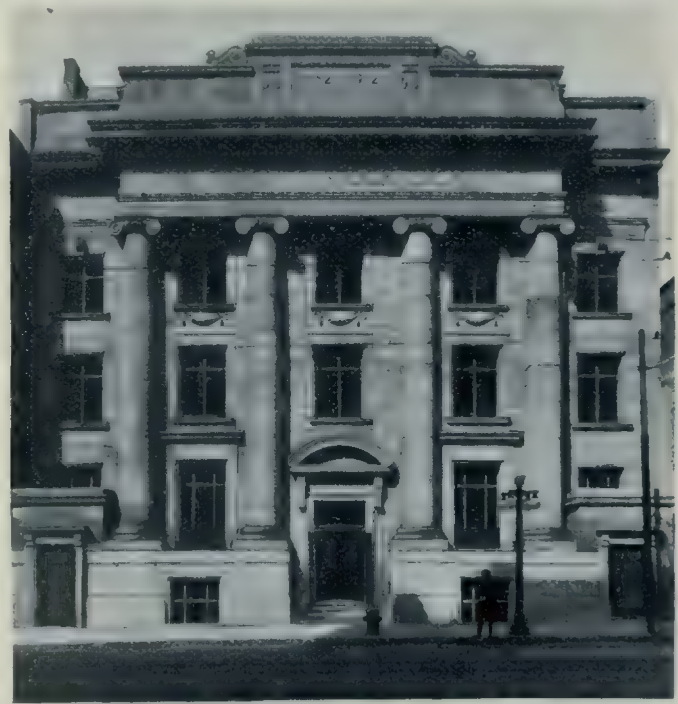
The famous German expert, Dr. von Emperger, maintains that the engineering profession has lost during the fifty years reign of steel as a structural material the appreciation of the good qualities of cast-iron, in proof of which qualities he quotes a number of cast-iron bridges which have served well during many years. To this may well be added that only those cast-iron bridges survived which possessed the fewest imperfections of this material. The doctor also has something to say about the behavior of cast-iron reinforced by hooped concrete because in his system it is not the iron which reinforces the concrete, but on the contrary the concrete which strengthens the cast-iron. Briefly, in reinforced cast-iron the function of the hooped material is to maintain the hooped concrete in an elastic state and that of the concrete is to maintain the surface of the brittle metal under the hooping pressure and thus eliminate its brittleness. The duty of the hooping material is not to increase the resistance of the embedded cast-iron, but to make it more reliable by protecting it against brittleness. The hooping may, therefore, be made so much lighter than for the usual hooped concrete. It must, however, be dense enough to insure a perfect envelope to the cast iron.

Toronto Stock Exchange New Building

Successful Solution of the Problem of Adapting a New Structure to an Old—The Signalling and Annunciator Installations

IN several respects the new building opened recently for the Toronto Stock Exchange is a unique addition to the structural features of the city.

The building, which stands on a site to the west side of Bay Street, has a frontage of 70 ft. and a depth of 100 ft. It was the original intention of the members of the Exchange to erect a new building on a property 40 ft. x 110 ft., but later an opportunity was afforded to purchase the adjoining property to the south. It was felt desirable that provision should be made for future expansion, and while the Exchange members did not care to involve the expenditure of building a complete new structure on the whole 70 ft. by 110 ft., it was considered feasible to tear off the front of the Fisher building, which comprised the 40 ft. of the lot, and alter this structure so as to conform with the requirements. The new facade across the complete frontage was therefore erected and the upper two storeys of the Fisher building were dropped back some 18 ft. in order to give the appearance of a complete new facade on Bay street. The problem in design resolved itself into joining the new building with the old structure, so that certain revenues might be obtained from the Fisher building section, and also that the Exchange might be enabled to use portions of the Fisher building in connection with their own business. As it was desirable that the main Exchange floor should be raised 6 ft. from the level of the street in order to secure privacy, a central entrance, devoted entirely to the use of the Exchange members, was provided. Two additional entrances, one for the office section of the new building, and one for the office section of the Fisher building, were made, thus giving three avenues of approach from Bay street.



New Building for the Toronto Stock Exchange.

As the floor levels in the Fisher building were determined, the problem in design was a difficult one, as a hard and fast rule as to proportions had to be followed. The difficulty of tying these different floors in proper levels of the new building arose, and it was also necessary to carry the parapet sufficiently high to mask the Fisher building section and give head room for a storey at this point. Provision has been made for possible expansion in the future by designing the steel in the main Exchange room in such a way that in the event of the tearing down of the Fisher building, the ceiling and skylights in the main room would form a symmetrical ceiling.

The new section of the Exchange is of Indiana limestone, and is of fireproof construction. Double steel doors at each connecting storey with the Fisher building are provided so as to minimize the risk of fire. The main entrance to the vestibule of the Exchange room proper is panelled in Jaune royal marble, to ceiling height. The floor is of grey Tennessee marble tile. On the left of the entrance vestibule is the members' cloak room, and a strangers' room on the right, together with toilet accommodation for the members. The main Exchange floor is 56 ft. x 42 ft. x i35 ft. in height. It is lighted through large windows from the rear and also from a skylight in the centre. The walls are panelled to a height of 9 ft. 6 ins. with quarter-cut oak. At the east end of the building, up one storey in height, is the visitors' gallery; on the opposite end of the main floor is located the president's rostrom, and between the main Exchange floor and opening directly after it, is placed the members' lounge room.

The interior furnishings are in keeping with the other features of the building. The floor in the lounge room, main Exchange room and the secretary's office, is finished in cork tile. A pneumatic tube station is connected up with the printing office on the top floor of the Fisher building, with the telegraphers' office in the basement, and also with certain brokers' offices in the front portion of the new building. Outside the accommodation already referred to, the remaining space of both new and old buildings is reserved for offices. The structure is heated by the "hot-blast" system, being brought in from a central heating plant. All air when it enters the building is first washed, then it is passed through heating coils and blown to the main Exchange floor; the balance of the building is heated by the "direct" system. This portion of the heating service is installed under the Webster vacuum type. All telegraph, telephone, ticker and annunciating wires run in metal conduits. Provision is made in all these services for possible expansion. The motor room for ticker service, pneumatic tube service, etc., are located in the basement, and at different points in the building, basement, and other floors, the necessary accommodation is provided.

The signalling and annunciator installations are interesting features of the building. This complicated equipment is modelled on that of the New York Stock

Exchange. The figures used on the annunciating board are said to be the largest in use in any Stock Exchange at the present time. The signal device is unique in that it automatically operates three "drops" simultaneously. Either from the private lines connecting with the private telephone in the Exchange or from the call board in the hall and telephone switchboard, these signals are so arranged that the member is able to determine whether the call comes from his own house, direct from the hall or from the switchboard. Provision is made for 60 telephones, but at present only about 35 have been installed. The lighting fixtures were supplied to special designs prepared and selected by the architect. Throughout the ladies' room, entrance hall, elevator halls, and Stock Exchange room, the furnishings are in statuary bronze, so as to harmonize with the other interior furnishings.

All the offices in the building are supplied with semi-indirect pendants fitted to moonstone reflectors finished in brushed brass. The remainder of the building is equipped with ceiling lights and steel high efficiency reflectors.

The architect was Mr. John M. Lyle, Toronto. The following were the contractors:—George Oakley & Son, cut stone; J. C. Scott Company, carpentry, etc.; Dominion Marble Company, marble; Rice, Green & Company, Limited, electric wiring and fixtures; Mr. F. C. Henderson, lighting fixtures; Fred Armstrong Company, Limited, plumbing, heating, and ventilating.

The Construction of Creosoted Wood-Block Pavements*

By R. S. Manley †

THE correct depth of concrete base or foundation varies with the soil conditions, but the materials and the methods of mixing are in such common use as to be standard and easily secured. We are interested principally in the construction placed on top of the concrete. The principal causes of defects of more or less serious nature are: 1. Irregular or uneven surface, due to careless laying, shifting of sand cushion, or breaking or settling of concrete; 2, expansion due to the entrance of water into the blocks either by way of the joints or from below.

An irregular or uneven surface is death to any paving material, because a depression in the surface holds water and repeated churnings of wagon wheels in the depression are bound to cause an enlargement and deepening of the depression.

The concrete of the base should be mixed quite wet and finished smoothly with a flat wooden spreader which gives a surface practically as even and uniform as could be obtained by template. On this should be spread ½ to 1 in. of clean sand, making the sand cushion conform to the contour of the finished street.

Then place the blocks quite close together, and roll thoroughly until a perfect surface with no inequalities has been obtained and until the blocks are firmly in place. It will require a great deal of rolling to accomplish this, but the end justifies the means. After this, fill all joints two-thirds full of hot bituminous filler of such melting point as is suited to climatic conditions, and spread a thin coating of sand. The use of the bituminous filler is most important. It converts the street into an effective watershed which without absorbing any of the water, directs it into storm sewers or other drainage paths. Should any water remain on the surface, the wind and the sun will rapidly dissipate it.

This construction gives an even waterproofed surface. This surface cannot be worn by traffic because the pressure of wheels is even and regular and there is no dropping or jolting of wheels entering and leaving low spots. As the blocks are laid tightly, there is no wearing at the joints. There can be no change in the sand cushion as long as the surface remains intact, a solid sheet in fact of wood block cemented together by the filler. It is assumed that the concrete is sufficiently strong so that it will not break or settle.

Expansion difficulties are eliminated by the use of bituminous filler, for there can be no expansion without absorption of water, and no absorption of water when all rainfall is conducted quickly to drainage sewers. In addition to this it must be remembered that with bituminous filler each block is surrounded by an individual expansion joint.

Another method of construction is to provide a mixed sand and cement cushion, and sand-filled joints or interstices. This cushion does not give the opportunity for absolutely smooth surface that the sand cushion gives, and is considerably more costly. The sand filler in the joints allows moisture to be absorbed in the pavement and ultimately this moisture gets into the blocks and trouble ensues. It is only on sheets of extremely heavy traffic that sand can be used as a filler without some expansion difficulties sooner or later.

It can be stated without fear of successful contradiction that every sand-filled pavement in the south has at one time or other given trouble from uncompensated expansion, and with equal confidence it can be stated that not one bituminous filled pavement has given trouble from this cause.

There have been objections put forward to the bituminous filler because of the belief that it would produce a sticky surface, disagreeable in warm weather. But if the proper filler is secured, and it is correctly applied there can be no such objection. The suitable filler has a consistency of rubber and can be taken in the fingers, bent and twisted without soiling the fingers. In applying this filler a spreader with squegee attachment places the filler in the joints where it is needed, and not on the surface of the blocks where it is not needed.

It is proper also to use less creosote oil per cubic foot of timber when bituminous filler is used, for the primary function of the creosote oil in this case is to preserve against decay instead of trying to make the creosote oil fill the double purpose of preservative and absolute waterproofer. No one familiar with preservative methods and history will question the efficacy of 16 lb. of creosote oil per cu. ft. in preserving against decay for an indefinite period.

The method of construction may be summarized as follows: Provide adequate smooth concrete foundation, use enough sand to cover any inequalities in the concrete or depth of blocks (except in railway areas and on grades, when use sand and cement mixed), lay blocks tightly, roll until smooth, fill joints with bituminous filler, spread coating of sand, and turn on the traffic.

On the ground of cheapness of construction, it is almost always better to put curtain walls in after the frame is up; the work then goes ahead much faster. Weather-tight joints can readily be made, and the joints between the frame, that is, the columns and floors, can be concealed so that no unsightly crack is visible.

---

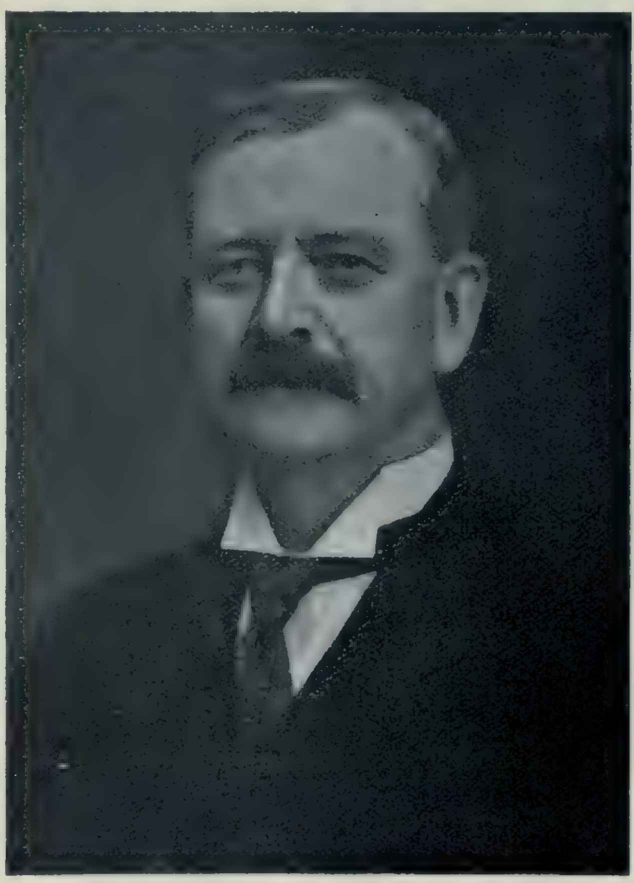
*Abstract of a paper read at the annual meeting of the American Wood Preservers' Association, at New Orleans.

†Creosoted Wood Block Paving Co., New Orleans, La.

The New President of the Canadian Society of Civil Engineers

THE election of Mr. Matthew Joseph Butler, LL.B., C.M.G., to the highest office in the gift of Canada's leading engineering organization was recorded in our issue of February 4, which contained a report of the last annual meeting of the Canadian Society of Civil Engineers.

Mr. Butler differs from many of his predecessors in office in that he has reversed an established principle. It has generally been the case when a man has succeeded to the position in the Canadian Society which Mr. Butler now holds, that he has come into prominence; that the Society has shed lustre upon him. Mr. Butler came into prominence years ago. For more than a decade he has been prominently in the eye of the constructional public in Canada. It is he who sheds lustre upon the Society. We say this not to the disparagement of the many excellent men who have preceded Mr. Butler in the presidential chair of the Canadian Society, but rather to emphasize the fact that Mr. Butler has been trained under the public eye and that he is essentially the kind of man who should play a dominating part in the development of the profession with which he is identified.


Mr. M. J. Butler, LL.B., C.M.G., Montreal.

The chief offices held by Mr. Butler were enumerated in one of the closing paragraphs of the leading editorial article published in our issue of February 4:—"The Society is to be congratulated upon Mr. Butler's succession to its presidency. As a former chief engineer of the Department of Railways and Canals, later Chairman of the Board of Management of the Canadian Government Railways, later again General Manager of the Dominion Steel Corporation, and now the executive head of the firm of Messrs. Armstrong, Whitworth of Canada, Limited, Mr. Butler has a long experience, and a breadth of vision gained therefrom, which cannot but be of inestimable value in the Society's work."

Mr. Butler's career has been a most diversified one and it is impossible in an article of readable dimensions to enumerate all of his various professional connections. Starting at the very beginning, before he had decided upon making engineering his life work, we find that he was born in Deseronto, Ont., in 1856, his parents being Tobias Butler, of the County of Wexford, Ireland, and Elizabeth McVey, of the County of Antrim, Ireland. Educated in the public schools and at the De La Salle Institute, Toronto, he proceeded to the University of Toronto and took what then constituted the "course" in civil engineering, which consisted of mathematics, science, English, French and German, scattered over the four years of the Arts course. At that time engineering proper was not taught in the University. In 1878 he was admitted both an Ontario and Dominion land surveyor. In 1895—bridging over a number of years during which he was engaged in various engineering and industrial enterprises—we find that he graduated in law at Chicago. He was admitted to the Illinois Bar in June, 1897. For some time he was engaged with Mr. M. J. Haney, the contractor for the Hillsborough bridge. In 1904 he was appointed Assistant Chief Engineer of the National Transcontinental Railway and the following year became Chief Engineer of the Department of Railways and Canals, to which in 1909 was added the position of Chairman of the Board of Management of Canadian Government Railways. He resigned in February, 1910, to become Second Vice-President and General Manager of the Dominion Iron & Steel Company and the Dominion Coal Company. This brings us down to modern times, which are covered in the extract from our previous article quoted above.

The new president of the Canadian Society is a man of wide interests and one who has extended experience in Society work. His connection with both the American Society of Civil Engineers and the Institution of Civil Engineers (Great Britain) ante-dates his membership in the Canadian Society. He is a member of the American Society of Mechanical Engineers, the American Geographical Society and the Royal Astronomical Society of Canada.

It will be seen, then, even from the above breviate, that the record of President Butler embraces phases of life, engineering and otherwise, which have not come within the experience of the average municipal or railway engineer who has attained the coveted honor in the Canadian Society. We make no apology for reiterating our belief that this long experience and breadth of vision, called into play on behalf of the interests of the Society, will make for greater development than has been in evidence in the immediate past.

Credit Foncier Building, Vancouver

Considerable progress has been in evidence during the past month in connection with the construction of the Credit Foncier ten-storey office building in Vancouver, one of the most substantial structures of its type at the Coast. The building occupies a central position at the corner of Hastings and Hornby streets, and is of reinforced concrete construction, with cut stone and terra cotta for the exterior facing, the whole being surmounted by a copper cornice. In the interior the floors will all be finished with rock maple. Marble wainscotting and terrazzo floors will be placed in the corridors. All the offices, with the exception of those to be occupied by the Credit Foncier, will be finished in oak. Mahogany will be used in finishing the quarters of the Credit Foncier. The Durham system of plumbing is to be installed throughout the entire building, and three passenger elevators will be at the service of the tenants. One of these elevators will be geared to carry 5,000 pounds weight. The plans for this building were prepared by Messrs. H. L. Stevens & Company, Vancouver, in co-operation with Messrs. Barrott, Blockader & Webster, architects, of Montreal. Construction work is being carried on by H. L. Stevens.

The ten-storey Credit Foncier Building now under construction at Vancouver.

The city of Ottawa, Ont., will replace the present wooden structure over the Rideau River on the boundary between the municipality and the township of Gloucester, with a new steel bridge 389½ ft. long. This bridge will be of a heavy through plate girder construction and will be made up of five spans each about 78 ft. long. It will have a 48-ft. roadway and two 6-ft. cantilever sidewalks, and will carry two electric car tracks. The roadway is carried on a 4½-in. reinforced concrete slab, supporting a 4-in. creosoted wood block wearing surface placed on a 1-in. sand cushion, drainage being effected by a camber of 6 ins. at the crown of the roadway and seep holes placed at the centre of each panel about 2 ft. from each main guide. Sidewalks are formed with a 3-in. reinforced concrete slab with the cement finish, with a slight slope outwards sufficient to drain. The piers and abutments will be constructed of a 1:3:6 concrete. The four piers and the south abutment will be carried down to rock. Test borings have shown that rock will be met at from 10 ft. at the abutment to 15 ft. at the north pier, below normal water level. The north abutment will be piled, concrete being taken down 10 ft. below water level; borings show rock at this point to be about 25 ft. below water level. The city having only a 60-ft. right-of-way at the north approach it was necessary to build a U abutment, keeping it as closely as possible on city property. The south abutment, however, is built with wing walls. Traffic will be maintained during the erection of the new bridge by a temporary structure placed about 100 ft. east of the present bridge. Designs for the sub-structure and super-structure were carried out under the direction of Mr. Archibald Currie, City Engineer, Ottawa, Ont.

Concreting in Winter

Some useful hints on the handling of concrete in freezing weather are given in a paper by Mr. L. C. Wason from which the following is abstracted: "The aggregates must be free from frost when mixed. A live steam pipe can be shoved into the sand pile, the escaping steam heating it and removing all frost. The same may be done with the stone, but a canvas should be thrown over the top of the pile to retain the heat which more readily escapes. Where a considerable amount of heating is provided for in advance, steam pipes are laid on the ground, and stone as received is dumped upon them. Then there is a canvas thrown over to prevent storms getting into the pile, and to retain the heat. The frost is thus easily and economically removed.

"Salt is frequently used in the water to lower its freezing point. It is seldom worth while to heat the water itself. Little care need be used to prevent mass concrete from freezing, as the frost will usually only strike to a depth of about one inch. Buildings are enclosed with tarpaulin tied onto an outside staging, and the enclosed space is heated with salamanders burning coke. Sometimes it is possible to use steam.

"Frost is removed from form work by the use of salt and steam, and if the concrete surface is left rough it is common to sprinkle the top surface with salt to prevent freezing. In winter it is very common to put the finish on as a separate operation, after building is enclosed, and not as an integral part of the construction, on account of the danger of freezing. When it is put on, it must be kept from freezing for the first forty-eight hours.

"The expense of protection against the weather is not very great, and good results can be so surely guaranteed that it is not usual for the writer ever to discontinue work on account of cold weather.

"Occasionally it is necessary to make some provision for the protection of the men. Shelters or windshields are built in front of the benches where carpenters are making up forms, as well as around the men at the concrete mixer, whose work does not necessarily keep them warm. Where excavation is going on in the open air it is expedient to have a building with a good fire where the men can warm themselves when necessary; and on a few jobs it has proved to be wise to furnish hot coffee free in these shelters."

New Vancouver Car Barn of the B. C. E. R.

THE British Columbia Electric Railway Company has recently placed in service at Vancouver a new car barn. At the present time the company has a barn in the centre of the city and another in the Mount Pleasant section. The new car barn is located in the western portion of the city, the company thus having barns distributed at several points, enabling it to arrange economically for the operation of early and late cars as well as provide quickly for special service in any section of the city.

The new barn is 400 feet long by 52 feet wide and will accommodate 64 of the company's city cars. In the construction of the car barn the entire site was excavated to a depth of 4 feet 8 inches below the street level. The excavation was then covered with a concrete floor 6 inches thick, and concrete walls 9 inches thick were built up to the street level. The floor from each wall has a slope of one inch in six feet towards the centre line, thus providing good drainage. For one of the tracks a jackpit three feet deep and one foot wide extends over 200 feet of track, this being the only break in the concrete floor. Upon this concrete base, along the line of each track, 12 by 12 inch posts were placed at 8-foot centres. These posts supported 12 by 12 inch stringers upon which the rails are laid at the street level. In this way easy access is possible in all parts of the barn to the under side of the cars.

The subgrade was generally hardpan, but in some places where the base material was not so good additional sills were placed under each of the 12 by 12 foot posts. At the resent time the walls above the street level are boarded with 2¾ inch shiplap, on which is placed galvanized iron. This form of construction is followed as it is expected in the future to build other units, possibly all of reinforced concrete type, at the same place. The shiplap boarding will then act as one side of the form for the reinforced concrete wall. The roof truss is of wood construction and is of simple type, the roof of the building being also of galvanized iron, with wired glass skylights every 32 feet. The building is generally lighted by 100 watt metal filament lamps, so arranged as to provide one lamp to each 192 square feet of floor area. The timber construction supporting the rails is completely wired, sockets being placed here and there for use in repair work. The building is equipped with a complete sprinkler system for fire protection, as well as with fire monitors, mounted on towers, just outside the building. These towers are about 20 feet high and support 6-inch stand pipes. The monitors have a range of 70 feet with a 2½ inch nozzle and the towers are placed 50 feet apart. The building is also equipped with a complete low pressure steam heating plant.

The car barn was built according to plans prepared by the company's architect and erected by day labor.

Vancouver Builders' Exchange—Annual Banquet

OPTIMISM was the prevailing keynote in the speeches at the first annual banquet of the members of the Vancouver Builders' Exchange held in the Elysium Hotel. Mayor Baxter and other speakers reviewed the period of stress through which those engaged in all branches of industrial activity in Vancouver had been passing in common with business men in all parts of the world and expressed the sanguine opinion that the chastening process would rebound to the ultimate good of the city and all concerned.

His Worship dwelt in reminiscent vein with the evolution of the city from a hamlet to its present proportions, alluding with pride to the fact that Vancouver was now entitled to take rank as the fourth city in importance in the Dominion. Touching on the financial stringency which has obtained during the past few months the Mayor deprecated the tendency to pessimism and pointed out that the change in conditions was causing business men to concentrate their efforts towards building up an industrial community—a change which would undoubtedly result in the establishment of affairs on a much more stable basis than previously existed.

Mr. W. M. Horie, the newly-elected first vice-president, acted as toast-master. Mr. Wm. O'Neil proposed the toast of the city and its executive, His Worship responding. The toast to the Board of Trade was proposed by Mr. E. G. Baines, Secretary W. A. Blair replying. Mr. J. L. Skene, the president, proposed the toast to the architects, Mr. W. M. Dodd, vice-president of the Society of Architects, and Mr. J. D. Beatson, honorary-secretary of the Society of Architects, responding. Mr. T. J. Madlen proposed the toast to the civic Board of Works, which was acknowledged by Ald. Hepburn. The city departments was proposed by Mr. D. H. Wilkie and replied to by Mr. S. M. Jarrett, building inspector, and Mr. J. G. Morgan, plumbing inspector. Mr. Booker proposed the toast to the press.

The following officers were elected at the previous meeting of the organization: President, Mr. J. L. Skene; first vice-president, Mr. W. M. Horie; second vice-president, Mr. T. J. Madlen; directors, Messrs. T. G. Bird, J. O. Perfect, T. Borgford, A. E. Lee, T. P. Morehead, D. H. Wilkie, J. G. Anderson, J. R. Wartman, H. N. Boultbee, E. G. Cullen, W. M. O'Neil, A. P. Bogardus, P. E. Ritchie and J. M. Douglas.

Reports were submitted by the president and the secretary, Mr. H. H. Lindsay, outlining the work since the Builders' Exchange was formed and dealing with the questions which would be taken up during the current year. Among the latter are proposals that joint conferences be held between representatives of the organization and the city authorities with a view to securing a revision of the building by-laws. The question of examining and issuing licenses to building inspectors, superintendents of buildings and clerks of works will also be advanced. It was stated in the secretary's report that it was the intention of the executive to considerably extend the scope of the exchange during the ensuing year.

The thirtieth annual meeting of the Connecticut Society of Civil Engineers was held last week at Hartford, Conn.

The forty-sixth annual convention of the American Society of Civil Engineers will be held in Baltimore, Md., early in June. The sessions will be held at the headquarters of the Engineers' Club, Baltimore.

The late Mr. Thos. M. McLeod, who died last month in Toronto, was a native of Georgetown, P.E.I., and a graduate of McGill University. He was only forty-six years of age at the time of his death. For several years he had been engaged in large excavating and reinforced concrete works in New York City and vicinity. In the operations which he had been carrying on for the city of Toronto he was associated with Mr. Ogden Merrill, of New York City. The late Mr. McLeod was highly esteemed on account of his geniality and unswerving integrity.

The members of the Toronto Builders' Exchange at a largely-attended meeting on February 9, Mr. Bulley, president, in the chair, decided unanimously to remove their headquarters to a flat on the fourth floor of the recently-erected building on the corner of Simcoe and Richmond streets for the Goodyear Tire & Rubber Company. The removal will take place about March 1.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The estimates of the Works Department in the city of Toronto for 1914 total more than $5,000,000.

The Essex, Ont., County Council, who have been considering road improvements estimated to cost $1,000,000, have postponed further consideration of the project until later in the year.

The annual convention of the Ontario Good Roads Association will open on February 24 and run over February 25 and 26. It will be held in the York County Building, Adelaide street, Toronto.

Tenders for the steel pipe in connection with Ottawa's eight-million-dollar water supply system have been extended to February 20. The bids will remain unopened until after a new plebiscite is taken.

Contracts, reported elsewhere in this issue, have been awarded for gas works estimated to cost $500,000, for the Ottawa Gas Company, Ottawa, Ont., for whom Messrs. Merrifield & Burnett, Toronto, are the engineers.

At Hamilton, tenders are about to be called for a steam plant to cost $3,500,000 to be erected by the Dominion Power & Transmission Company, according to plans prepared by Messrs. Prack & Perrine, 36 St. James street, Hamilton.

Plans have been prepared, by the Montreal Electric Commission, for conduits on a number of main streets in the business section, and for St. Lawrence Boulevard, from Ontario street to the river. Tenders will be called for this work early in the spring. The conduits are for power and other cables, and will involve the doing away of poles.

The Canada Machinery Corporation, Limited, has been reorganized on a comprehensive and satisfactory basis. Enterprising plans were formulated at a meeting of the bondholders at Galt last week. The company foresees renewed activity and increased prosperity, not merely in view of general conditions but also having regard to its own immediate financial concerns as now arranged for.

The National Brick Company, Montreal, will reopen their plants at Laprairie, P.Q., on the 20th inst., with a production of 300,000 bricks per day. The plants have been closed down since the end of November. The outlook for Montreal brick companies is more bright than it was last year, when there was overproduction. There is almost certain to be very extensive building of residences and flats, which are in greater demand than supply.

The Montreal Board of Control is now considering the largest and most expensive annual programme of public works ever undertaken in the city. The total reaches over five million dollars and includes the laying of twenty miles of permanent pavements in the down-town district and extensive macadamizing in the outside wards. This will cost $1,500,000. Expenditure of $1,091.000 is earmarked for sidewalks, $1.700,000 for sewers, and $760,000 for the aqueduct.

The Quebec Builders' Exchange held their annual banquet at the Victoria Hotel recently with Mr. C. E. Morissette, President of the Exchange, in the chair. The function was attended by the Mayor and many other local officials, as well as by Mr. R. P. Lemay, on behalf of the Architects' Association. Mr. E. T. Nesbitt, who is well-known as one of those intimately identified with the development of the building trade in Canada during the last few years, congratulated those present upon the regulations governing building construction now in force in Quebec.

A large programme of public works to be carried out during the summer has been prepared by Mr. G. Janin, engineer to the city of Montreal, who has now practically recovered from his recent illness. The programme will entail the outlay of $5,000,000 and provides for the laying of about twenty miles of permanent pavements in the centre of the city and a large amount of macadamizing in the outside wards, an expenditure of $1,091,000 for sidewalks, $1,700,000 for sewers, and $760,000 for the aqueduct. A sum of $100,000 will be put aside for repairs to certain streets.

Under the Quebec Government Bill, the Montreal Parks Commission has been given enlarged powers. The city is authorized to advance sums of money to the commission for the preparation of a general plan of improvements for the Island of Montreal. The cost of carrying out the improvements as contained in the plan is to be paid by the municipalities interested in the work, but the commission must not execute any part of the plan without having obtained the consent of the municipalities, or if they refuse, authorization of the legislature must be secured. The cost is to be met by a special tax imposed by the municipalities.

An attack has been made on Messrs. Lea, Jamieson, and Hackle, the engineers employed by the city of Montreal to report on the break in the water conduit. The allegation was that these gentlemen were connected in a direct or indirect way with the Cook Construction Company, who are carrying out the contract for enlarging the aqueduct, which work, it was asserted, was in a measure responsible for the accident to the conduit. Messrs. Lea, Jamieson, and Heckle have written to the Controllers, stating: "No member of this engineering board has now, or has ever had, any connection whatsoever, directly or indirectly, with the Cook Construction Company, or any member of the said company, or of any other company that has carried out work for the City of Montreal on the water-works, intake or conduit, or enlargement of the aqueduct." The Ambursen Hydraulic Construction Company of Canada, Limited, of which Mr. G. R. Heckle is manager, have also written denying any connection with the Cook Construction Company.

WESTERN CANADA

Edmonton, Alta., is to have an isolation hospital at a cost of $350,000 if the ratepayers approve of the by-law which is to be submitted on March 10.

The sum of $570,000 is to be spent on main sewers and outfalls at New Westminster, B.C., where Mr. J. W. B. Blackman is the city engineer.

The Canada Cement Company's plant at Exshaw, Alta., was destroyed by fire last week. It is stated that the fire will necessitate closing the plant until the buildings are reconstructed, although the company have such a large stock of cement on hand that it will not interfere with their business. The Calgary plant, which was closed, will be started immediately and will be kept in operation until the reconstruction of the Exshaw plant has been completed.

A tunnel sewer at an estimated cost of $900,000 is an item included in the estimates for the city of Edmonton, Alta. Mr. A. J. Latornell is the city engineer.

At Calgary, Alta., Mr. A. Pirie, a local architect, is completing plans for an Industrial Housing Building, estimated to cost $250,000. The building will be of six storeys and basement. Excavating is to start at once.

Tenders for four viaducts, estimated to cost $540,000, will close at Vancouver on March 4th. These structures will span the G. N. cut at Hastings, Pender, Keefer and Harris streets. Individual and collective tenders are invited.

The city council of Regina, Sask., has accepted the proposal of Messrs. Coste & McAuley, of Calgary, to supply gas at the city limits and the ratepayers will be asked to vote on a by-law to raise in round figures $4,700,000 for the installation of a system.

At Kindersley, Sask., surveys are being made for a reservoir estimated to cost $125,000. The construction will include earth and concrete dams about 4 ft. high and 1,000 ft. long, also 2½ miles of steel pipe and an installation of low pressure electric pumping machinery.

Sir John Jackson Company, Limited, contractors for the new breakwater at Ogden Point, B.C., have arranged for the first shipment of granite blocks from Nelson Island to form the base of the concrete structure which will be placed in position as soon as more settled weather prevails.

The Estevan, Sask., Board of Trade has two propositions in mind with a view to investigating the possible supply of oil and gas at Estevan. One is that the town undertake the sinking of a deep bore at the expense of the ratepayers. The other is that the citizens form a stock company and do the work by private enterprise, receiving by way of security a franchise from the town.

The Alaska Railway Bill directing the president to purchase and construct 1,000 miles of railway in Alaska at a cost not to exceed $40,000,000 has passed the United States senate by a majority of 46 votes to 16. The bill places upon the president the responsibility for the selection of the route from tidewater to the interior of Alaska, and the construction, equipment and operation or leasing of such lines as he may construct or purchase to constitute this route.

A company, to be known as the Vancouver Railway and Ocean Terminal Company, is seeking incorporation by special act of Parliament to build a line about three miles in length across the city of Vancouver. The railway would be on the south side of False Creek, designed to connect the joint False Creek terminal with deep water frontage and wharves, which it is proposed to erect at Kitsilano reserve, in connection with an improvement scheme under the harbor commission.

The Saskatchewan Presbytery, Regina, is still working on the proposition to erect a $1,000,000 demoninational college and the site and grants for this instiution have been secured. It is expected that some arrangement will be made for the erection of the college during 1914. The Roman Catholics of Regina also have in view the erection of a college. This college was to have been commenced last year, but it is believed that it is to be considered during the present year.

The Dominion Government will contract for the erection of a substantial armory at Regina during the present year. It is understood that this building will cost in the neighborhood of $200,000 to $250,000, although provision is only made for the expenditure of $75,000 during the present year in the estimates. The government has also announced its intention of the erection of two other substantial buildings at Regina at a cost of $75,000 each. One of these will be a customs building.

The Canadian Pacific Railway are building a line from Golden, B.C., to Fort Steele, having acquired the Kootenay Central, which was abandoned, after 12 miles had been built. Trains are operating from Golden south as far as Spillimachene, while steel has been laid much farther and grading is progressing far ahead of the steel. Work is being urged north from Fort Steele to Golden. This will bring the miners of the rich Windermere silver-lead distric within a range of 250 miles of the large custom smelters and within but a few miles of Trail, B.C., where most of the silver-lead smelting is done.

The new structure known as the P. O'Sullivan Building, just completed in Calgary, is claimed to be the record in rapid construction work in that part of Western Canada, having only taken seventy days to complete. It is three storeys in height, with a full-sized basement, the latter being of reinforced concrete, the upper storeys having fireproof walls. A marble front gives the store a striking appearance, the hall and staircase leading to the upper flats being finished in the same style. The back of the structure is built of red glaze brick, while the side walls are of hollow tile. Mr. J. Henderson is the architect and Messrs. McDougall & Forster are the contractors.

Mr. T. R. Cornick, contracting engineer, Vancouver, was recently awarded an important contract covering the erection of 43 miles of wooden pole transmission line for the city of Kamloops, between the city's hydro-electric generating station on Barriere river and the sub-station in Kamloops. The contract calls for the use of 45-foot wooden poles with steel core aluminum conductors, equivalent to No. 4, B & S. guage solid copper. Spans will average 200 feet. This will be a 45,000-volt line, using pin type insulation manufactured by the Locke Insulator Company. The line will carry a ground wire at the peak, and one metallic telephine circuit. Messrs. DuCane, Dutcher & Company, Vancouver, are the consulting engineers for the city of Kamloops in connection with the extensive scheme of hydro-electric development, of which this work will form a part.

Interesting figures have been prepared by the advising engineers connected with the Burrard Peninsula (Vancouver) Joint Sewerage Commission for the apportionment of the cost of the work to be executed or to be taken over by the commission during the current year. It is proposed in a more or less tentative way, depending on the sale of bonds by the commission, to undertake more than $1,500,000 worth of new trunk sewer construction, which with engineering expenses and the amounts payable to the city of Vancouver and Point Grey for sewers already built will bring the proposed expenditure of the board up to $1,645,000 for the season. The programme of work for the year, which has already been started is confined at present to the China creek and Canoe creek districts, serving ward eight of the city, the north end of South Vancouver and the Cedar Cottage district. Several branches radiate through the district and finally combine to make the proposed Clark drive sewer, emptying into Burrard Inlet. The estimated cost of these items is: Knight road and Canoe creek extensions, $249,600; Clark drive outfall, $319,000; extension of Main street trunk to Central Park, $354,200; Gladstone branch, $40,700; Earl's road branch, $15,400; Main street branch, $154,200; engineering, $78,000; total $1,256,700. Included in this figure is also the cost of an investigation advised by Engineers Rust and Thomson in reporting to the government when the act was passed last August. The cost will be $45,000.

Important Constructional Projects at St. John, N.B.

Correspondence of the Contract Record

THE citizens of St. John are congratulating themselves upon the success of the commission plan of government, which St. John was the first city in Canada to adopt. After a two years' trial, with civic affairs administered by five commissioners, each the head of a department, devoting all his time to the city's business, the results show a decided improvement over the old irresponsible system, with a mayor and board of aldermen, most of the latter being elected to represent different wards and several elected at large. The city's treasury department has just issued its annual statement, which shows that there was a considerable unexpended balance in every department at the end of the year, the whole amount totalling $105,000, of which amount $50,000 was devoted to the relief of this year's assessment, $25,000 to retire some bonds, $18,000 to improve the water distribution service and the balance for other public purposes. While the debt of the city is shown to be a little over $5,100,000, the assets exceed this sum by $2,575,000, and the city controller in his report was able to say:—"The city's financial position the past year was certainly a very easy one compared with the majority of other cities in Canada." The present city council during its two years in office has done a good deal of permanent street paving, improved the street lighting in the business centre and extended the water distribution service.

To Enlarge the Dry Dock

The plans for the dry dock at Courtenay Bay provide for a dock only 900 feet in length. The Board of Trade is now taking up with the government the question of increasing the length to 1,150 feet, so that this dock would be as large as any to be constructed in Canada during the next few years. Norton Griffiths & Company are also suggesting that the wharves which they are to construct at Courtenay Bay be built of concrete, and this matter is being taken up with the government at Ottawa. Mr. Norton Griffiths has assured the Board of Trade that his whole contract, including the dredging of Courtenay Bay, the wharves, the breakwater and dry dock will be completed well within the contract time, and to this end the Norton Griffiths Company has taken over all the work from the sub-contractors, and will itself make provision for speeding up the work of construction on the whole contract.

Hon. S. O. Bigney, of Attleboro, Mass., is in St. John to form a company to take over the Canadian patents and manufacture in this city a new type of suspenders which are now being manufactured in Attleboro for the American market. If the company is organized, it will mean the employment of a large number of operatives and add another to the many lines of goods turned out from factories in St. John. T. McAvity & Sons hope to be in a position to let the contract for their big iron and brass manufacturing plant early in the spring.

The city of St. John owns a large area of land desirably located in the adjoining parish of Lancaster. Dnring the past year there has been much talk over a proposal to have a part of this area divided into lots upon which cottages would be erected for working men. The city council has given the matter a good deal of consideration, and last week the Mayor was given authority to bring an expert from Montreal to make a survey of the lands and suggest a town development plan, following which some action would be taken to offer a means of relieving the congestion of population in the growing city. This property is located near West St. John, but the extension of the street car service is a guarantee that there will also be development this year at East St. John, where considerable building was in progress last year.

The Maritime Dredging & Construction Company has been awarded the contract to construct 2,240 linear feet of new wharves at West St. John. This is the contract begun by Connelly & Charleson. The new company has just given an order for 5,000,000 feet of hard pine timber and has taken over the contracts from the old firm for 8,000,000 feet of hemlock and 1,500,000 feet of hard wood, which is now being got out in the forests of New Brunswick. The E. G. M. Cape Company, who are building the big sugar refinery, have been given the sub-contract to construct the concrete face and surface of the new wharves and will soon assemble a large plant for that purpose. The timber cribs which will form the substructure of these wharves must be of great depth, as they must extend over thirty feet below low water and provide also for a rise of tide of twenty feet. This contract is to be rushed to completion as rapidly as possible, so that at least two steamship berths may be available for next winter.

The St. John city council will ask the provincial legislature to enact a law which will provide that the property owners on streets which it is proposed to provide with permanent pavement shall pay one-half the cost. In some Canadian and many United States cities the property owners must pay the total cost, and in some the proportion ranges from 50 to 100 per cent. Under the present law in St. John, the property owners on any street may have it paved on agreeing to pay half the cost, but one-third of the property owners can block the improvements; and the council is asking authority to go ahead unless 60 per cent. of the property owners protest. All the street paving that was done last year was done on the basis of half payment by the property owners and half by the city; but the provision in the law enabling one-third of the former to block progress, prevented the council from carrying out as extensive a programme as it had planned. There is a good deal of opposition to the proposed change, and it is said this will be carried to the legislature by those who contend that the whole city should be assessed for all street paving. Whether the new law is adopted or not, the growing demand of the citizens for street improvement will ensure a continuation of the permanent paving policy which has been carried out for the last two years.

The steel frame of the new post-office has now been erected to the height of three storeys. The steel frame of another of sugar refinery buildings has been erected, and rapid progress is being made by the contractors. T. McAvity & Sons, in asking the city council to fix the taxation on their new iron and brass manufacturing plant at $5,000 a year for forty years, stated that there would be an initial expenditure of $300,000, and that when the whole group of sixteen buildings was assembled on the new site it would represent an expenditure of about $2,000,000. Their plans have been completed and they are ready to begin construction work early in the spring.

The federal government has provided in the estimates brought down at Ottawa recently for an expenditure of more than $3,500,000 in public works at St. John, including harbor works, the new post-office, breakwater, a spur line of railway to Courtney Bay and other important works. There is so much general construction work in sight that this promises to be even a busier year than last in and about St. John. Norton Griffiths, M.P., was recently in the city making arrangements to take over the sub-contracts for Courtnay Bay work and have them carried on by the Norton Griffiths Company. It is announced that more dredges will be brought to Courtenay Bay and that the work on the great breakwater and dry dock will be accelerated with a view to the completion of the whole contract within two years.

The railways department at Ottawa has asked the city for the plans of two new wharves which the city is asking the government to build, just above the wharf of the sugar refinery. A railway trestle with a draw, to permit the passage of schooners, now crosses the area, and it would be necessary to divert the railway and dredge out the basin in order to provide deep water wharves. If the government decides to carry out this work, it will greatly increase the wharf accommodation where it is much needed on the eastern side of the harbor.

Personal

Mr. H. L. Fitzsimmons, building inspector for the city of Prince Albert, Sask., has resigned.

Mr. George D. Mackie, of Swift Current, Sask., has been appointed City Engineer and Commissioner at Moose Jaw.

Mr. Charles H. Keefer, of Ottawa, has been elected to the directorate of the American Society of Civil Engineers.

Mr. Angus Smith, the newly appointed City Engineer of Prince Albert, has taken up his duties in the Saskatchewan city.

Mr. D. W. Johnson has been appointed engineer to the municipality of South Saanich, B.C., at a salary of $3,000 a year.

Mr. J. Jonsson is Acting City Engineer of Saskatoon pending the appointment of a successor to Mr. George T. Clark.

Mr. T. Aird Murray, consulting engineer, Lumsden Building, Toronto, is removing to fresh quarters at 186 King Street West, Toronto.

Mr. W. G. Chace, Chief Engineer of the Greater Winnipeg Water District, addressed a meeting of the University of Manitoba Engineering Society last week.

Mr. J. H. Haffa, architect, has opened an office at 209 Peterkin Building, Toronto. Mr. Haffa has been associated for the last three years with Mr. J. A. Harvey, 165 Bay St.

The Edmonton Engineering Society held a meeting on February 5, when Mr. J. M. Bogg, Assistant City Engineer, delivered an interesting paper, entitled, "The Tunnel Sewers of Edmonton."

Mr. Franklin Remington, of the Foundation Company, is the new president of the General Contractors' Association of which Mr. C. A. Crane, 51 Chambers Street, New York City, is the secretary.

Col. A. J. Van Nostrand has been elected President of the Engineers' Club of Toronto. The First Vice-President is Mr. Chas. H. Heys, the second, Mr. W. A. Bucke, and third, Mr. E. L. Cousins.

Mr. Geoffry C. Ommanney has been appointed special engineer to Sir T. Shaughnessy, president of the C. P. R. Mr. Ommanney was appointed resident engineer in Montreal for the C. P. R. in 1908.

Mr. Arthur V. Ruggles, who was at one time employed by Messrs. Hazen & Whipple, a New York consulting firm well known in Canada, has been appointed Assistant Engineer of the Water Filtration Bureau of the city of Cleveland, Ohio.

On February 9th Mr. H. W. Durham, Chief Engineer in Charge of Highways, Borough of Manhattan, New York City, delivered an illustrated lecture on "The Highways of Panama," before the Graduate Students in Highway Engineering at Columbia University.

Mr. F. J. Robinson, Regina, formerly Deputy Minister of Public Works, has been appointed Chairman of the Highways Commission of Saskatchewan in succession to Mr. A. J. McPherson, who has been promoted to the Chairmanship of the Government Finance Commission.

In our report of the Canadian National Clay Products Association published in our issue of February 4, we misspelled the name of Professor Edward Orton, Jr., of the Ohio State University of Columbus, Ohio, who gave an interesting address on the subject of Ceramic Schools. We are indebted to the Dunn Wire-Cut-Lug Brick Company, of Conneaut, Ohio, for the correction.

Mr. F. W. Cowie, engineer of the Montreal Harbor Commissioners, is in Europe, visiting various ports. Mr. Cowie will examine the developments carried on at London and other British ports, and will also investigate methods at Marseilles, Genoa, Hamburg and Antwerp. A paper on Montreal Harbor will be read by Mr. Cowie at a meeting in London of the Institute of Civil Engineers.

Dr. Wm. A. Parks, Professor of Mineralogy in the University of Toronto, recently delivered an interesting lecture in the Physics Building of the University on "The Building Stones of Eastern Canada." The lecturer gave a review of the chief building stones in Ontario, Quebec and the Maritime Provinces. He spoke at length on the possibilities of marble and granite in Canada, of which he said there was an excellent supply. He expressed the opinion that the future of building in Canada depended on the production and use of these classes of stone over those of the more common kinds. Cement, he explained, was largely replacing the ordinary kinds of stone, as was shown by the fact that most of the quarries not producing marble or granite were lying idle at present.

American Road Builders' Association—New Officers

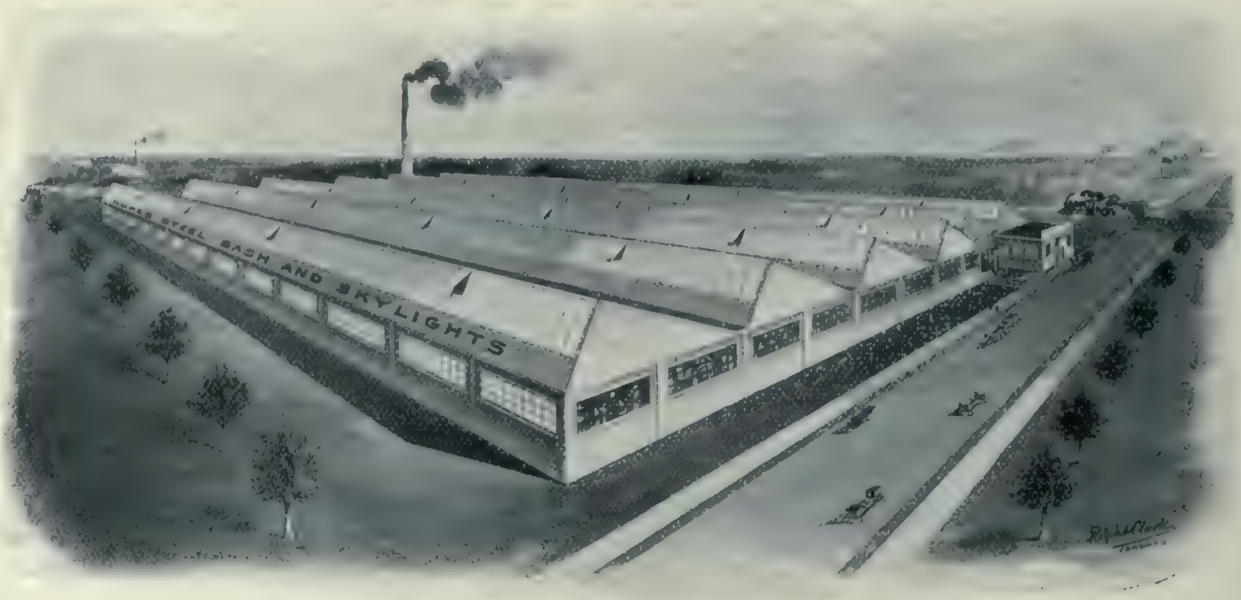
The annual meeting of the American Road Builders' Association for the election of officers was held at the Hotel Astor, New York, N.Y., February 6. The following officers and directors were elected:—President, Mr. W. A. McLean, Commissioner, Department of Public Works, Toronto, Ont.; First Vice-President, Mr. Geo. W. Tillson, Consulting Engineer, Borough of Brooklyn, N.Y.; Second Vice-President; Mr. A. W. Dean, Chief Engineer, Massachusetts Highway Commission, Boston, Mass.; Third Vice-President, Mr. A. B. Fletcher, Highway Engineer, California Highway Commission, Sacramento, Cal.; Secretary, Mr. E. L. Powers, Editor "Good Roads," New York, N.Y.; Treasurer, Mr. W. W. Crosby, Consulting Engineer, Baltimore, Md.

Directors for Three Years

Mr. Samuel Hill, President, Washington State Good Roads Association, Seattle, Wash.; Mr. Paul D. Sargent, Chief Engineer, State Highway Commission of Maine, Augusta, Me.; Mr. A. H. Blanchard, Professor of Highway Engineering, Columbia University, New York, N.Y.; Mr. R. H. Gillespie, Chief Engineer of Highways, Borough of the Bronx, New York, N.Y.; Mr. Harold Parker, Ex-Chairman, Massachusetts Highway Commission, Worcester, Mass.; Mr. Fred E. Ellis, Manager, Essex Trap Rock & Construction Company, Peabody, Mass.

The reports of the Executive Committee, the Secretary and the Treasurer were presented. These showed a large gain in the active membership of the Association, while the financial condition was found to be very satisfactory. Altogether the work of the Association during the past year has been the most gratifying in the history of the organization.

The Frontenac Floor and Wall Tile Company have just completed a factory at Kingston, Ont., for the manufacture of interior sanitary tile for floors and walls. The factory has been built with Canadian capital and is operated by Canadian labor. It is a one-storey building, of brick and steel construction, well lighted on the four sides. The machinery equipment is of the very latest type. The factory has the advantage of good shipping facilities, it being located at the


HOPE'S STEEL SASH AND SKYLIGHTS

New factory at Peterborough, Ont., of Messrs. Henry Hope & Sons of Canada, Limited.

junction of the C. P. R. and G. T. R. main line, in close proximity to water routes through the Great Lakes. The R. D. Farnham Company, 911 New Birks Building, Montreal, are the sales agents. The company manufacture tiles of every description, including art panels and decorative tile, mantel tile, and also floor and wall tile. In addition they handle mantels and andirons in copper, hammered brass and wrought iron in a variety of designs and finishes.

Prince Albert Builders' Exchange—Annual Meeting

At the annual meeting of the Prince Albert Builders' Exchange, the following officers were elected for the ensuing year: President, Mr. A. W. Knox; Vice-President, Mr. G. A. Meyers; Secretary, Mr. John R. Davidson; Treasurer, Mr. G. B. Mitchell; Auditor, Mr. R. Stevenson. Directors:—Messrs. A. P. Andersen, G. E. Winter, H. W. Davy and Jacob Thompson. Mr. H. W. Davy was delegated to attend as a representative of the local exchange at the annual convention of Builders' Exchanges held in Moose Jaw on February 16. The report of President Knox and Treasurer Mitchell showed that the financial condition of the organization was most satisfactory despite the recent hard times. The secretary, Mr. John R. Davidson, gave a review of building operations during 1913, making a forecast of greater activity during 1914. According to Mr. Davidson's report, the Prince Albert Exchange is developing steadily and before long will become an important factor in the local building situation. Among the matters which are engaging the attention of the Exchange may be mentioned, employers' liability and state insurance; the wage clause; wages of carpenters and bricklayers; the hours of various trades, and the duty on stone and cement. An interesting feature of the latter part of 1913 was the inauguration of lectures given by prominent business men of the city. The first of these addresses was given by Mr. J. Melrose Morrison, architect, and the second by Mr. H. L. Fitzsimmons, city building inspector. Both of these lectures were well attended and much instructive information was given. The officers and members of the Prince Albert Exchange are united in the aim of making the present year one of unprecedented achievement.

An Up-to-date Steel Sash Factory

By the end of the month the new Hope factory in Peterborough will be ready for business. This plant is said to be the finest of its kind in America. The building is all brick and steel and shows well the adaptability of Hope's steel sash and saw-tooth roof to the modern factory. The Hope people's claim of "Daylight factories" is remarkably demonstrated in their own plant. The factory is 200 ft. long and 180 ft. wide. We are told by Mr. Young, the vice-president and manager of the company, that the machinery for this plant has all been specially designed for them and embodies the very latest improvements in steel sash machinery. They claim that their method of straightening their sash bars by hydraulic pressure is one of the great achievements in steel sash manufacture and is superior in that the bars are not distorted in any way and make an absolutely plumb sash. The factory is fitted throughout with steel carrying tracks and travelling cranes and apparently is a perfectly equipped steel sash plant. The Hope announcement and photograph of their factory is shown on page 35.

The Herbert Morris Crane & Hoist Company, Limited, Toronto, are associated with Herbert Morris Limited, the English firm who have just received from the London and North Western Railway Company an order for ten 10-ton hand overhead travelling cranes and two electric cranes. This, together with an order for eight 12-ton hand cranes, from the London and South Western Railway Company, makes the largest contract of the kind that has been placed for some years past.

A particularly interesting trade publication is "A history of the trade-mark, Yale," received from the Yale & Towne Manufacturing Company, New York. The booklet contains a record of cases in which the company's rights have been sustained. It is prefaced by a sketch of the origin of Yale products. This prefatory part contains many illustrations of interest to those concerned with this line of manufacture. It is pointed out that the benefit of the trade-mark accrues not only to the manufacturer, but to the public and the consumer in establishing and identifying an article of assured quality.

ESTABLISHED 1886
Contract Record
and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 February 25, 1914 No. 8

Principal Contents

Page
First Canadian and International Good Roads Congress. 221
Specialization in Honors 221
Reinforced Concrete Caisson Construction in Breakwaters at Goderich, Ont. 222
Reinforced Concrete Engineers 225
Present Status of Sun Power 226
Discussion of the Engineer-Manager Plan of Municipal Government 228
Proposed Aqueduct for the Additional Water Supply of the City of Winnipeg 231
Fundamentals of an Extended Experience in Sewage Disposal 235
Problems of the Waterproofing Engineer 238
By W. H. Evans
An Analytical Study of Composition Flooring Material. 241
By H. M. Hooker.
Types of Hollow Tile Fireproofing—Their Manufacture and Burning 243
Progress at Vancouver and the Coast 245
Appointments: Mr. W. A. McLean and Mr. W. Furniss Clark 248-9
Vancouver Builders' Exchange 250
Constructional and General News 248-252

First Canadian and International Good Roads Congress

THE First Canadian and International Good Roads Congress which is to be held from May 18 to May 23 in the New Birks Building, Montreal, promises to be an event of considerable interest. It will take place under the auspices of the Canadian Highway Association and the Canadian Automobile Federation. The Exhibition has been arranged on the suggestion of several large manufacturers interested in the Good Roads movement, and matters relating to good roads legislation, the problems of construction and maintenance, the advancement of road-building, engineering and other questions of practical assistance to the movement in Canada will be discussed. It is felt that by a co-operative advocacy of a uniform system of road-building, proper methods and economical management, more practical work will be accomplished. Appropriate papers dealing with the various phases of road work will be read and discussed at the daily sessions, and prominent speakers from Canada and the United States will be present. An important feature in connection with the Congress will be the official opening of the King Edward highway, 45 miles long, connecting Montreal with the New York State roads. Invitations have been extended to government representatives, engineering societies, automobile clubs, and others interested in the Good Roads movement, and a large and representative gathering from all parts of the Dominion is anticipated. Mr. George A. McNamee, 909 New Birks Building, Montreal, is the General Secretary.

Specialization in Honors

SOME little time ago a proposal to abolish titles in Canada was defeated in the Commons at Ottawa, it being ruled that it was the royal prerogative to confer such honors. Personally, we are not of a socialistic temperament; indeed, we are rather in sympathy with one who defined the effort as "a colossal presumption." That, however, is another story. We are concerned with the question only from the viewpoint of the Contract Record and Engineering Review, and in that way we confine ourselves to commenting upon the suggestion raised by a London contemporary, namely, that in place of knighthoods, C.M.G.'s, K.C.M.G.'s, and so on, it would be a good idea to have a special Order for engineers and men of science who have rendered conspicuous service to the community. It is pointed out that titled folk, after all, are a very mixed lot and that it is impossible to find a common denominator of distinction for military men, legal experts, stock-brokers and company promoters, contractors, government and provincial officials, newspaper publishers, doctors, and so on. Undoubtedly there is a good point here. Of all classes of men who are playing an important constructive part in the country at the present time, none is better deserving of recognition than the engineer and the contractor, and it is on behalf of the interests identified with this journal that we join in the plea for some specialization in titles. A man who carries to successful completion a great engineering enterprise which will remain for generations as a monument to his ability and a boon to posterity is surely deserving of recognition equally with the man who makes millions cleverly but selfishly and afterwards distributes thousands in the cause of philanthropy. It is pointed out that the late King Edward appreciated the difficulty and solved it in a few cases by establishing the Order of Merit, and it is well contended that if King George were to follow the example and institute a new title for the engineering community, the honor would be coveted by some of the best men in the country and would impress upon the public the fact that mere makers of money are not their sole benefactors.

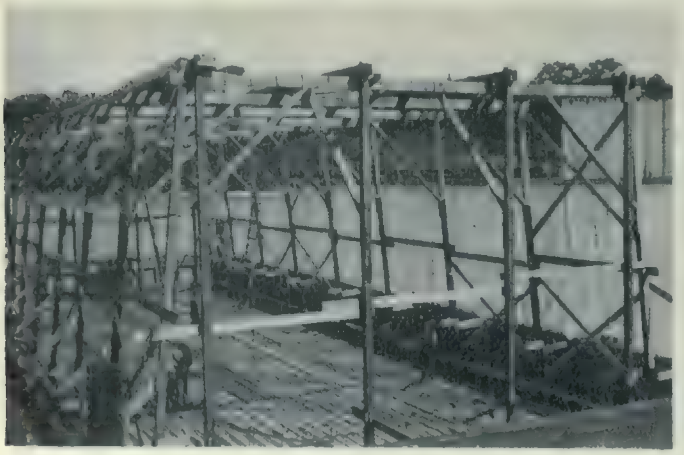
STRICT regulations governing the design and construction of picture houses should be enforced. The "moving picture show" has taken hold of the people and taken hold with a vengeance. Cinematograph entertainments, however, like every thing else that is attractive superficially, are all r
taken in moderation only. Probably the most

objection to them is their effect upon the eyesight. Apart from that their effect upon the general health is likely to be most harmful if the buildings are badly ventilated and not suited for the purpose. In many cases the surroundings are anything but hygenic, the ventilation is miserably inadequate and the floors and walls are **lodgments** for all kinds of vile germs. The strictest surveillance over these places should be kept by our building departments and the reconstruction of old and unsuited buildings should be tabooed.

Advantages of Reinforced Concrete Caisson Construction as Exemplified in Breakwaters at Goderich, Ont.

DURING the last three seasons a very interesting work has been in progress at Goderich, Ont. This consists of the construction of breakwaters, the substructures of which are of reinforced concrete caissons filled with stone, gravel and sand and the super-structures of mass concrete. This is the first instance in which caissons of this character have been used in breakwater construction in this country. Some few years ago caissons somewhat similar in design but much smaller in size were successfully adopted by the United States War Department in the construction of breakwaters at Racine and Milwaukee.

After inspecting and studying these works, Lt.Col. Lamb, the District Engineer of the Department of Public Works in charge of harbours and rivers in Western Ontario, supervised the design and preparation of plans and specifications for the construction of six hundred feet of breakwater to provide partial protection from the south-west storms to the entrance to piers at Goderich. The survey and detailed calculations were made by Mr. E. H. Drury and Mr. M. K. Cameron, assistants.



Framework and reinforced iron erected in scow ready for concrete work.

The plans were submitted and approved by the Department and a contract for the work was subsequently awarded to Mr. Wm. Bermingham, of Chatham, Ont. The cost of the work including inspection amounted to $141,383.56.

The caissons are 100 feet long, 26 feet high, 35 feet wide at base and 30 feet at top. When placed they reached to 2 feet above low water level and were set in a level berth carefully prepared by dredging and swept to the required grade. The material on which the caissons were set is stiff clay and gravel, with a small percentage of sand in a few places. The settlement since the structure was completed is practically imperceptible.

The weight of each caisson was approximately 1,711 tons in air and it was left to the discretion of the contractor whether he would build them on ways, and then launch them, or build them in a floating dry dock. He chose the latter method and constructed for the purpose a scow 114 feet long, 44 feet wide and with sides 11 ft. high. The bottom of the scow was designed with a view to avoiding buckling during course of construction. The end of the scow was fastened with hinge attachments at the lower end to permit of opening outwards and to allow egress of caissons when they were floated out of the scow. Rubber gaskets were attached and these prevented any leakage. Previous to construction the scow was pumped dry and ascertained to be free from leakage. The reinforcing iron for the floor of the caisson was laid and the reinforcing for the walls erected in frame work.

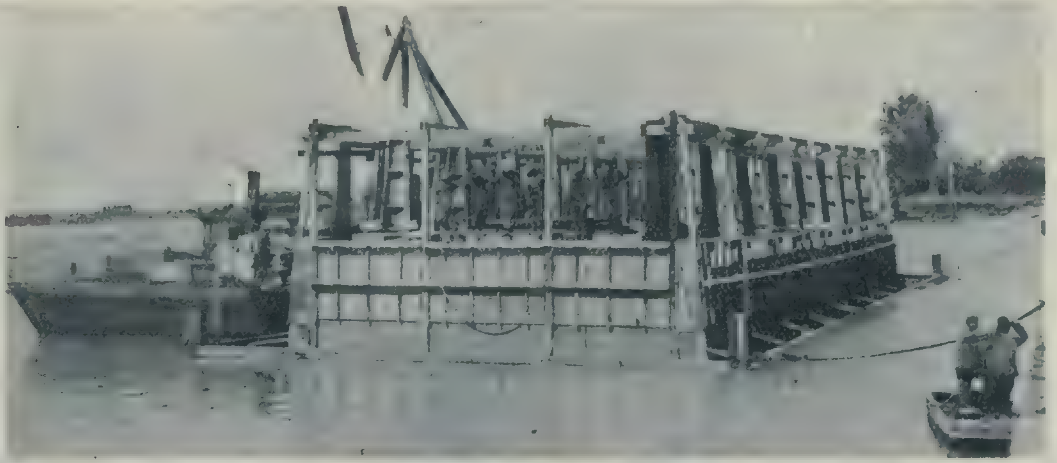
The concrete in floor was then laid, this being fed from a skip handled by a derrick placed beside the concrete plant on the dock adjoining, and sometimes from a floating plant placed on the harbour side of the scow.

The forms required for the first lift of the outer walls and the division walls were then erected and the concrete was brought up in lifts of 3 feet, the face, longitudinal, and division walls being constructed similtaneously. The forms were then raised as required.

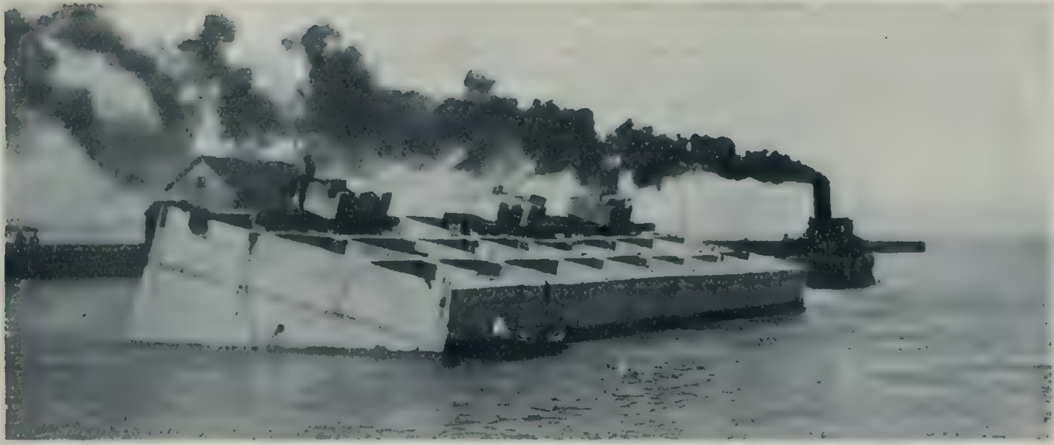
Special care was taken in the daily testing of the sand and gravel to ensure the adoption of the best possible mixture. To this, together with the care exercised in the mixing and placing of the concrete, is attributed the success in securing practically water-tight caissons. The average mixture used consisted of 5½ bags of cement to one cubic yard of gravel, or a proportion of 1 to 6.

When resuming concrete work on walls already built, care was taken in thoroughly cleaning the roughened surface of the old work. A wash of one to one mixture was then applied. Good bond was thus secured throughout.

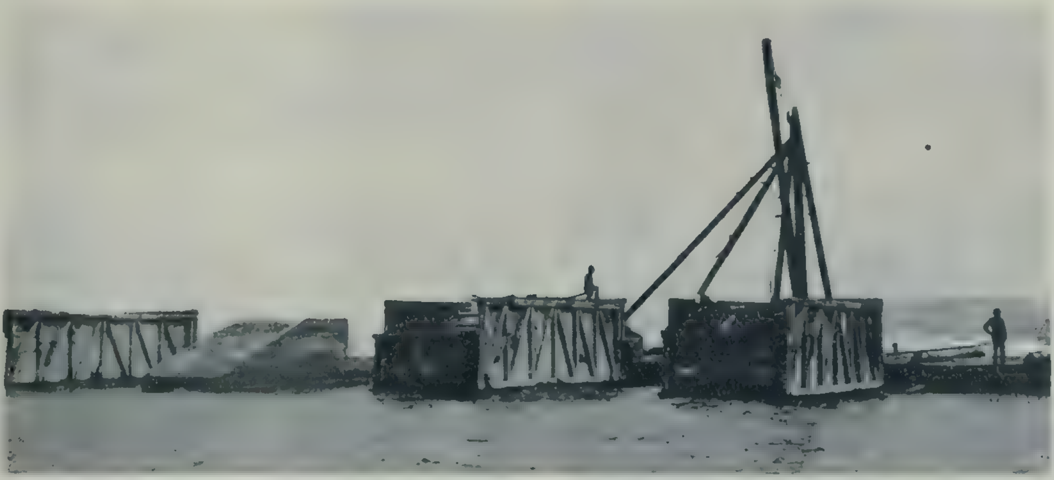
When the caisson was constructed to a height of about fourteen feet eight inches, the scow had settled to a point where the top of the sides was nearly level with the surface of the water. The scow was then sunk by pumping water into the space between the sides of the caisson. The scow and concrete blocks were also lowered into the space to assist the parting of the scow from the base of the caisson and to ensure the sinking of the scow to the bottom. The end door of the scow was then opened and the caisson towed out. The completion of the caisson (floating on its own bottom) was then proceeded with. In the meantime, by lifting out the concrete blocks and closing the end door of the scow, the structure rose until the sides were above water. It was then pumped out, and within four hours and a half from the time the cais-



Sinking scow.

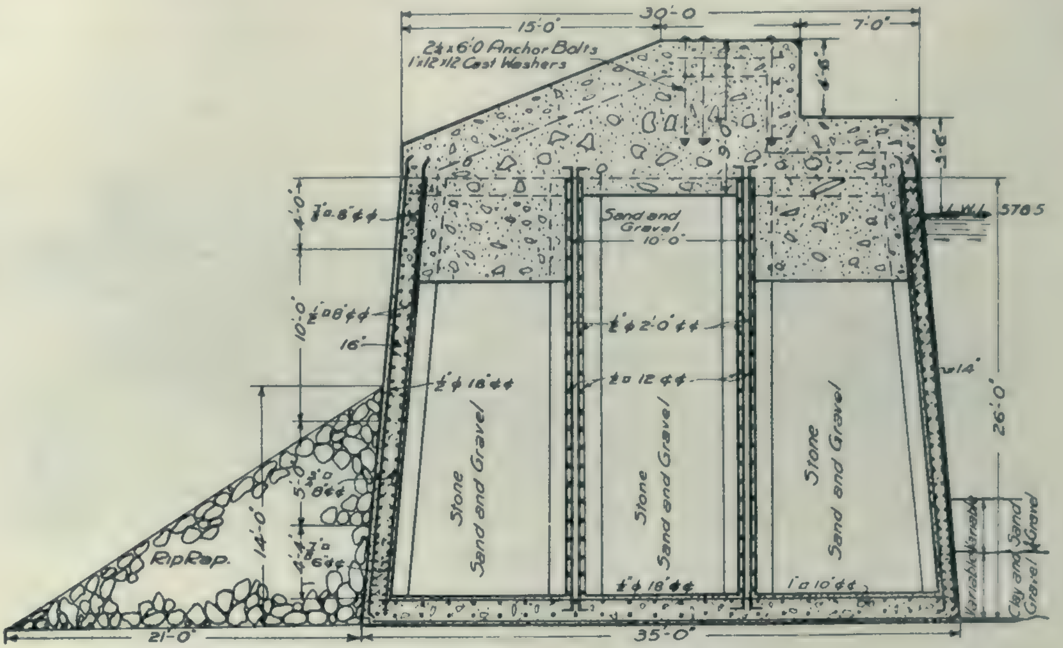


Cassion being towed out to site of breakwater.



Forms utilized in construction of superstructure and independent blocks.

REINFORCED CONCRETE CAISSON WORK AT GODERICH, ONT.



South breakwater. Cross section of first 600 feet.

son was floated out the scow was ready for the construction of another caisson.

In the fall of 1911 three caissons were built, filled with water, and sunk in the inner harbour for the winter. The remaining three caissons were constructed between April 25 and July 4, 1912, and between June 28 and July 12, 1912, the six caissons were towed out to the site of the work and lowered into berths already prepared for them. The sweep used consisted of a reinforced concrete beam, 12 in. x 12 in. x 40 ft., and was suspended from a scow to the required depth. Owing to the greater thickness of the outer or sea-face wall of the caisson, the inner face wall was partly loaded with concrete blocks, while the caisson was being towed out into position to better equalize the draught.

To secure proper alignment, standards were fastened at the centre of each end wall and lined into position by transit on shore. The caisson was held in the required alignment by block and tackle running to dead men on either side formed of heavy concrete blocks. The process of sinking was then started by filling the caissons with water. One 6-inch centrifugal pump was used and the time occupied in sinking and completing the filling of the caisson with water was about five and one-half hours. When thus filled, the safety of the caissons was assured. The work of filling with stone, gravel and sand was then proceeded with, after which the construction of the superstructure of mass concrete followed. In building the latter, independent monolith blocks, 10 feet wide, spaced 20 feet apart, were first constructed and the intermediate spaces were then filled in. The forms were lifted into position by derricks and carefully set to line and elevation. The filling of the form was then performed in one continuous operation.

The concrete mixture used in the super-structure was practically the same throughout, viz., 5½ bags of cement to one cubic yard of gravel, or in the proportion of one to six, with the exception of the five feet of meagre concrete in the outer pockets of the caissons. The heavy character of the forms, and the protection which these offered to the exposed face and surface, reduced to a minimum the danger from storms once the block was completed. The construction of the

Concrete caisson partly constructed in scow and forms raised.

Six caissons sunk in extension of 1000 ft. to northwest breakwater.

super structure was started on July 31, 1912, and completed August 29 following.

On May 17, 1912, a contract was also awarded to Mr. Bermingham for the construction of an addition of one thousand feet to the existing north-west breakwater and of a design such as that already described, except that four of the caissons were 28 feet in height. To date, six hundred feet of this work is completed, with the remaining four caissons built and sunk in the inner harbour for the winter. This structure is exposed during storms to an extremely heavy wave blow, the fetch from the north-west being about 175 miles.

In making the calculations for this design, able assistance was given by Mr. H. B. R. Craig, Colonel Lamb's Senior Assistant, who also rendered valuable service in supervising the construction of the work.

It was found that the factor of safety which it was deemed wise to adopt when constructing the initial work of six hundred feet of the south-west breakwater was sufficiently large to permit of the adoption of the same design as to thickness of walls, size, spacing of reinforcement, etc., for the extension to the north-west breakwater. A large floating plant, consisting of tugs, derrick scows, concrete mixing barge, etc., is in use by the contractor. The contractor's success in the work is due to no small extent to the untiring efforts and careful direction of the Superintendent of the work, Mr. W. L. Forrest.

Southwest breakwater nearly completed and forms for intermediate blocks under erection.

In view of the assured success of this work, the adoption of the design has been decided on by the government in connection with the terminal improvements at Cape Tormentine, N.S., and also at Victoria, B.C., where the intention is to build and place concrete caissons considerably larger than those described in this article.

The principal advantages over timber crib construction appear to be as follows:—

(1) More permanent in character.

(2) Risk in sinking and filling practically eliminated.

(3) Better alignment secured.

(4) Sub-structure can be carried up above water level and thus facilitate the construction of the superstructure.

The Resident Engineer on the work is Mr. V. M. Roberts and the inspector, Mr. George Higginson.

There appears to be no doubt that this class of structure will be utilized largely in the future and it is to the credit of the Department of Public Works that it has been so successfully initiated in this country.

Reinforced Concrete Engineers

OWING to the widespread employment of reinforced concrete in the present day, and to the large number of firms and persons undertaking to supply designs and estimates for work in that material, it is more than ever necessary for consulting engineers, architects and prospective clients to consider the qualifications of those who specialize in the design and execution of such work.

This warning is particularly called for to-day, as architects are getting more and more into the habit of asking for competitive schemes from various firms, without much, if any, regard to the competency of those invited to submit designs. A method of procedure which thus places scientific and experienced engineers on the same level as mere business firms without technical qualifications is economically unsound for obvious reasons.

A system embodying the principle of competitive designs which are to be judged on the utterly incongruous basis of the estimated cost of the works contemplated, instead of by the intrinsic merits of the designs themselves, cannot be too strongly condemned. It puts a direct premium on cutting tactics, which must tend to diminish the adequacy of all designs submitted, and it should always be remembered that a design which is the most economical in first cost may not be the most economical in last cost, this being especially true in the case of structures subject to severe stresses and atmospheric conditions.

Even if a competition is limited to a small number of experienced firms there is no guarantee that the best design will be accepted, as the assessor appointed generally possesses far less experience of reinforced concrete work than the highly specialized firms competing on what is virtually a "lowest estimated cost" basis. Under such conditions it is possible for a clever but not over scrupulous designer to find loopholes in the rules and regulations specified as a standard for the competition, and while apparently working in strict accordance with the rules, to get out an exceptionally ingenious, if not ingenuous, design complying with the understood desire for low cost, but involving risks of serious nature.

To obviate the disadvantages inevitably attending the method chiefly followed to-day, it is necessary for the consulting engineer or architect in the first place to differentiate between commercial specialists who are interested as contractors, merchants or manufacturers, and specialists who work on professional lines. Those coming within the first category may appropriately be asked to submit quotations or estimates when the time has come for the receipt of tenders, only those in the second category being invited to prepare designs, which must be judged by the criterion of efficiency and not of mere cheapness.

In the second place, the engineer or architect will be well advised in selecting one professional firm whose reputation and past record is such as to justify absolute confidence. The same process of selection is widely adopted in connection with ordinary engineering and architectural projects, where the co-operation of a structural, electrical, sanitary, ventilation, or heating specialist is necessary, and there is every reason for adopting it in cases where the essentially specialized work of designing reinforced concrete structures has to be performed. As the specialist engaged would have nothing to consider but the interests of clients, the latter would secure the important benefit of projects embodying every possible economy consistent with safety and reliability.—Ferro Concrete.

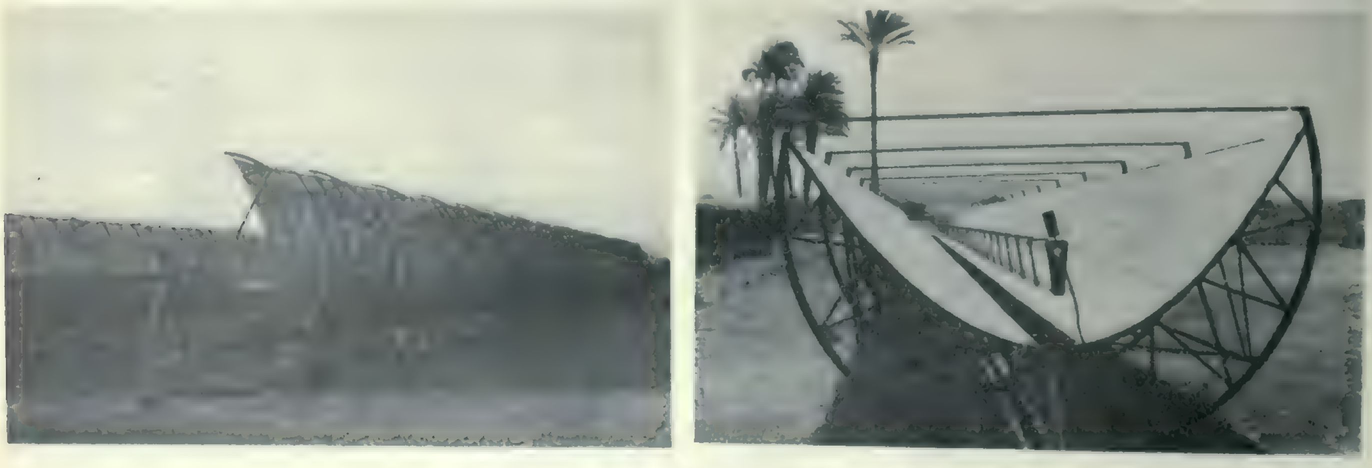
The Present Status of Sun Power

SOME interesting particulars concerning the history and present status of sun power are furnished by a London, Eng., correspondent who has discussed this latest development with the inventor, Mr. Frank Shuman, of Philadelphia. There is now in operation at Cairo, Egypt, an irrigation plant which derives its power entirely from steam generated from water by the rays of the sun. The cost of this plant was kept down to reasonable limitations by constructing the entire framework of the heat-absorbing portion of the plant in such a manner that the pieces are practically uniform and can be made quickly and cheaply by ordinary machinery from light structural iron. The manner in which mirrors are used is well illustrated on the accompanying views. These mirrors are made of ordinary window glass, specially silvered and protected, and cost only five cents a square foot. The foundation posts are of concrete and are made in place. The engine, pump and auxiliaries are the same as in any good coal-burning steam plant, except that the cylinder of the engine is larger, owing to the fact that low pressure steam is used. The heat-absorbers and steam generators are constructed entirely of concrete, steel, and glass—materials which will last many years in the tropics. The iron being easily accessible can be painted every six or eight years. The heat-absorbers are constructed to withstand a wind pressure of thirty pounds to the square foot. The Cairo plant consists of a low pressure reciprocating condensing steam engine of 100 h.p. and a reciprocating pump with all the necessary auxiliaries.

As the entire engine and pump portion of the plant is practically identical with that of ordinary coal-burning ones—except that the engine is specially invented and constructed so as to run very economically on low pressure steam—we will confine ourselves to a description of the sun heat-absorbers and steam generators, which take the place of the boilers, furnace and stack of the coal-burning plant. The value of the whole group of inventions lies in these sun heat-absorbers, which generate the steam required to run the engine from the direct rays of the sun.

These heat-absorbers and steam generators are, in this particular plant, five in number. They are 200 feet long and 13 feet wide at the top. They consist of parabolic frames and very light structural iron set with mirrors in such a manner that these mirrors catch the sun's light and reflect it all on the two sides of the long boilers, suspended in that portion of the frame where the sun's light converges. Every five square feet of sun light received by the mirrors, is focussed thereby upon one square foot of the boilers, thus quintupling the light power on the said surface and enabling it to raise the temperature of that surface to 600 deg. Fah. As the steam pressure is not allowed to go over atmospheric pressure (equal to 212 deg. Fah.) the temperature of the boilers never goes above 212 deg. Fah., and the excess heat is transmitted into the water and produces great volumes of low pressure steam.

The boilers are flat throughout the bottom where the water is carried and along the whole top of each runs a 3½-inch diameter steam pipe, which gathers the steam along the whole line and carries it from each of the boilers into the main steam pipe through which it goes to the engine. The boilers are constructed of cast-iron in the present plant, but in future, plants will be stamped out in 12 feet long pieces from



Type of self-adjusting mirrors used in the Shuman sun plant.

one-eight inch thick steel tubes, very quickly and cheaply.

The steam after passing through the engine and doing its work is condensed into water, and pumped again into the boilers. Thus the same water is used over and over again, and only the very little needed to compensate for accidental leakage is added. As practically no new water is used there is no danger from the boilers becoming clogged with mud or scale.

High pressure steam up to 300 lbs. per square inch can be generated by these heat-absorbers, but this is not done, mainly because at the high temperature of this steam too much heat would be lost by conduction and convection into the surrounding air, and secondly, because were high pressure steam used, the boilers would have to be very strongly constructed and cost considerably more money, and necessitate heavier frame construction to carry them than is now the case.

The five heat-absorbers carrying the boilers are set in line due north and south on rollers and gears, carried on proper foundation posts of concrete and are turned slowly from an eastern aspect in the morning to a western one in the evening, so that at all times of the day they exactly face the sun, and generate steam. To effect this exact facing of the sun throughout the day, a very ingenious adaptation of the thermostat was invented, which we have not here the time to describe in detail.

Shuman sun power plant .Machinery equipment.

The very important element of expansion and contraction was carefully considered in the construction of these heat-absorbers, and many trials were made before all the disturbances were eliminated. The boilers are covered with a single thickness of window glass to prevent loss of heat. Generally speaking from every acre of surface covered by mirrors 250 h.p. can be obtained.

As further experience is gained, and better machinery acquired for manufacturing sun power plants, the cost as compared with a coal-burning plant will quickly go down. By availing ourselves of well-known methods of storing heat by means of boiling water, a sun power plant of any size can be constructed to run night and day and even through one or possibly two rainy days if necessary. By means of this storage in tropical countries, perfectly steady power can be given throughout the twenty-four hours. Sun power can be generated in large plants located in the desert proper on the border of cultivatable land and the power transmitted by electricity over large areas.

The construction of the Egyptian sun power plant is particularly simple, and thoroughly practical in every way. Any ordinary engineer can run it. Owing to the fact that ordinary materials are used in its construction, repairs can be easily made and everything is above ground and accessible.

A wash, consisting of a dilute solution of hydrochloric acid, one part of commercial 30 per cent. acid to five parts of water, has been found effective in cleaning the stains, due to weather, and other causes, from the concrete surfaces of lock walls. A test was recently conducted on the center wall lamp standards of the middle lock at Gatun. The surface of the concrete was brushed over with the solution, and afterwards was rinsed with clear water. The application and subsequent rinsing freed the concrete of all discoloration. The process has proved satisfactory, but will be kept under observation before further work is done.

Some concrete fences recently erected in St. Louis are of a combination shop and field built type. The posts, 6 x 8 inches above ground and 12 inches square below ground, were made in a shop. They were from 9 to 10 ft. high, the portion under ground being 3 ft. long. The posts were then erected about 6 to 9 ft. centers, and five ½ in. diam. horizontal bars placed in holes in the posts at a uniform vertical spacing, to serve as main panel reinforcing. These bars reach only from centre of posts, so as to provide, in a measure for expansion and contraction of the concrete. Vertical rods 3/16 in. in diam., are tied to the horizontal bars at intervals of about a foot. Solid concrete panels 4 in. thick were then cast between the posts. The panels were scrubbed with wire brushes as soon as forms could be removed, while the posts have a troweled finish.

Engineers are asked to be chary of taking positions that require the accompaniment of cash. We hear that a raid was made recently upon a Cleveland firm who had been advertising for engineers and had induced them to part with some $30,000. The attraction was a permanent position with the concern, but the great engineering enterprises which it professed to have on hand never materialized. It is well contended that reputable firms with large contracts want brains and not money in driblets of a few thousands. Here in Canada, fortunately, our experiences of deception in the engineering field are few, but we are not immune from the possibility of being imposed upon and a note of warning may be sounded in time.

Engineers employed in the construction of new wharfs at Terminal Island, San Pedro, Cal., have been experimenting, with considerable success, with vitrified clay pipe as a protection to piles, from the destructive parasites. It has been the custom heretofore to creosote the wood piles to protect them from the ravages of the teredo and linoria. This process is expensive, and by the use of vitrified clay pipe it seems that the problem of securing a less costly substitute has been solved. The wooden piles are covered with 14 or 16 inch clay pipe, the pipe being placed over the piles as soon as they are driven, and allowed to sink with their own weight into the mud at the bottom, and the space between the pile and the pipe filled with sand, which is particularly disliked by both the parasites mentioned.

1914 28(8)

Efficiency of the Engineer-Manager Plan of Municipal Government

THE matter of an improved form of administration for Canadian towns and cities has engaged our mind for many moons and our ideas have been translated into several editorial articles published in these columns. Whether effectively or ineffectively—we hesitate to express an opinion—our articles have provoked considerable discussion, in witness whereof we refer to many valuable contributions published in recent numbers.

In our issue of January 21 we referred editorially to the City-Manager plan of government which had gone into effect at Dayton, Ohio, and we suggested that a discussion of the scheme would be timely. With a view to focussing the attention of our readers upon this point in the hope of bringing out the possibility of other forms of administration it may be well to give a few leaves from the experience of the city of Abilene, Kan., where a population of five thousand is governed by the Engineer-Manager form of government. Our information is abstracted by our Chicago contemporary, Engineering and Contracting, from a paper by Mr. Kenyon Riddle, who holds the position of Engineer-Manager at Abilene.

The success of any good business is possible if it is controlled properly. Imagine some piece of construction work being carried on by a body of men and each man having equal authority, or a railroad under such conditions. Nevertheless, this is the encumbrance which a great deal of city work struggles against. However, work done under standard specifications is saved by the clause, "All instructions shall be given to the contractor through the engineer." This clause guards against the unlimited confusion that would result if no one person were made the head.

In maintenance work and the general business of the city, though, is where confusion arises from too many men giving directions to the city's employees and from giving individual orders. Every important move of the commission should be acted upon by the body as a whole, then delivered to one man for disposal or distribution to the proper heads or departments. This removes individual action by any one member of the board, and it also cancels any feelings of jealousy among the board members. It makes the commission as a body responsible for the act and the one man is made to account for putting this act into service. The manager, being a salaried man with no definite term of office, naturally would strive to give his best service, since the length of his term depends upon his capability.

Preferably the manager should be without extensive interests in the town or city which he serves. This makes it more possible for him to give impartial views in matters concerning employment of labor and purchasing of material. His preparation should consist in a thorough education along the lines of general engineering rather than a knowledge of a few special branches. This will make it possible for him to advise and check up, in a general way, every act of the engineering department. He should also have an understanding of values and be able to estimate all classes of construction and maintenance work, be economical and able to establish systems of record-keeping and cost-keeping, and have a general conception of business methods and finances. In addition to this he should have an understanding of the city's sanitary and social conditions, which exert an important bearing upon public welfare. Inefficiency here causes every imaginable trouble. Here is involved the street cleaning and disposal, water system and supply, sanitary sewer system, drainage system, the working and living quarters of every class of people, the transportation facilities, and numerous other items.

A general knowledge of all of the above particulars is not too much to expect of a city manager. However, since men have not prepared themselves for this particular situation it may be well to try the new system of control in smaller towns, for in these places some of the qualifications of manager can be stricken out entirely and others are of much less importance. On the other hand, in the larger cities the different departments are more complete in themselves and would require less direct supervision and advice from the manager.

Since these requirements have been enumerated it is not at all difficult to see that the great majority of the city's affairs are of an engineering nature and should be managed by an engineer.

Adaptation to Towns and Small Cities

Since the engineer-manager plan is especially applicable to the average sized towns of 3,000 to 25,000 or 50,000, and since its success is more probable in these places, let us confine ourselves to this particular application.

In order to demonstrate the importance of the adoption of this more simplified form some of the defects of the older and more complex forms might be brought out. These innumerable defects have been the cause of an awakening on the part of the people who wish better administration.

People have commenced to see that public affairs as a rule have not been handled in a business way, but rather along lines of politics, and when business becomes mixed with politics then efficiency is replaced by inefficiency. Instead of each member of the governing board exerting his efforts along the lines he believes to be best and in a manner desired by the people, he is very often misled by reason of political views. Appointments are very often made because of favoritism or by reason of political debt. Also due to politics, every citizen is not treated on an equal basis. Improvements are centered around certain localities, and are not distributed in an impartial way. Everyone is aware of the fact that money is wasted in nearly all public business. Some of the dissipation of the tax money is often due to graft, etc., but most of it is the result of poor management, lack of harmony among the board members and a lack of knowledge along particular lines, especially in the engineering department of smaller towns and the purchasing department of nearly all municipalities. No doubt the larger cities lose money in their engineering departments, due to lack of management, and the department is possibly hampered by politics. Nevertheless they do not lack in principles of engineering practice as do the smaller towns.

Therefore, in consideration of the small town the main object in order to secure efficiency where it is most lacking is to devise some scheme whereby the town can feel justified in having the services of an engineer at all times, and this remedy lies in the engineering-manager plan. It will be shown later on how the creation of this office is possible for any town and how it can be made remunerative.

We might account for wastes due to a complex system of management. The particular duties of different officials and departments are not well defined, thereby causing confusion and resulting in loss of time, which is loss of money.

Wastes due to lack of harmony are quite common. This lack of harmony is usually traced back to differences of politics or possibly jealousy among the different members. Without harmony there is no unity and without unity all advancement is retarded.

Source of Greatest Waste

But the principal dissipation of funds comes from lack of knowledge, and this particular shortage is most often conspicuous in the engineering department, and since the great majority of the city's business is of an engineering nature this makes up the greatest waste. This particular argument best fits a small town, since these are the towns which are believed to be too small to feel the necessity of employing an engineer the year around. These are the places where a lack of knowledge makes up the principal reason for receiving about three-fourths value on each dollar spent in taxes. The permanent improvements and systems in such places are the nucleus for possible larger systems. Therefore they should be carefully planned so as to meet future conditions. They should be accurately recorded also.

If a town or city had some means of figuring the money wasted in prospecting for lost underground systems, in the improvements buried and never found, in systems that are built with no idea of future growth and that have to be abandoned years before they are worn out, in the grading and re-grading of streets, in sinking hundreds of dollars into permanent culverts and waterways built with no idea of future drainage and that have to be broken out when pavement is laid, it would be no difficult matter to prove the economy of city planning and of proper management.

How could anything else be expected from a council or commission composed of bankers, lawyers, farmers and men who have devoted their efforts to their professions and who are in active business and cannot neglect it to make a study of engineering so as to carry out some drainage proposition or such for the city, their salaries being anything from $1 to $25 per month?

As soon as a town reaches a size which justifies permanent improvements, from that time on systematic methods should be carried out, and a capable man who is paid a fair salary and feels permanency in his position is more apt to be able to do these things than a council or commission. It very seldom is the case that the successor will follow plans laid down by his predecessor. On the contrary, not only will he refuse to follow his predecessor's plans, but he will exert his efforts in tearing them down.

With an engineer-manager it is possible to get the very best and most active business men to serve on the commission, since their duties are reduced to a few hours a week. Furthermore, it is generally admitted that the holding of a political job is not a successful means of increasing one's business, but under the new plan all complaints and grievances may be put to the manager, such as come up every day of a lack of water pressure, sluggish sewers, poor drainage, etc.; and since he is not elected by the people, but appointed by the commissioners, he may be free to act as one whose best judgment is not overpowered by some political fear. By hiring a manager the hindrances of politics are eliminated and professionalism is substituted.

Can anyone argue that this will not bring about efficiency? The average person cannot realize that paying what now seems like an exorbitant salary for expert men is economy. The principal reason is that one can see the expense of salaries, but can not discern the huge waste due to poor and inadequate management. This waste invariably exceeds the expenditures that might be made for men capable of handling public affairs.

Now, the way to eliminate these objectionable features of the old style of admniistration is to adopt commission form of government as the executive board and as representatives of the people, and for them to select, by purely business methods, an expert through whom they can look for professional advice. As a result of this professional advice many blunders in the town's affairs can be overcome.

Deplorable Condition Under Present System

Every person here who has had any experience with the different systems of a city well knows the deplorable conditions which some of these are in. The distribution of the water comprises a length of misfit, complicated pipes and valves, with absolutely no records of the underground system—the result of having untrained, inexperienced men who wish to experiment along the lines of engineering, all at the expense of the city. Due to the fact that the town had no engineer, they thought it would be economy to plan and supervise their own systems and extensions. During the time that the town is small and when these errors are being made is the very time to put into practice every method of city planning, since this is the foundation of a possible larger system. And, by all means, permanent records should be kept of all underground work.

It is needless to say that the sewer systems suffer the same inexcusable poor treatment. These mistakes all bring about complicated and unnecessary expense to the city.

Also think of the money wasted in drainage systems. This is one feature on which the incompetent street commissioner of a small town professes profound knowledge. Costly and permanent waterways, etc., are built to care for drainage, with absolutely no idea of drainage, of adequate capacity, of the future outcome or development of the scheme. In a few years, the street is paved and it then becomes necessary to tear out hundreds of dollars' worth of these permanent improvements. The only means of overcoming these items of waste is for the city to proceed along lines which will insure expertness. If they were to employ an outside engineer for these less important things doubtless it would be too expensive, but the proper procedure is to devise some method whereby the town will have an engineer at their service at all times. Salvation lies in the adoption of the engineer-manager plan.

Now, to make this newly created office remunerative: The employment of an engineer as manager no doubt will be considered too expensive, especially for a small town. The thoroughness of record keeping which it is possible to maintain would more than obviate this objection. But there are several ways in which an income to the city's general fund can be realized by the newly created office: No matter how small the town, all sewer work, plumbing, wiring, water mains and services, meters, etc., should be inspected, and the small cost for doing this should be charged to the property owner. Then there will be the ordinary expenses of surveying lot lines, giving grades for buildings and sidewalks; this would be charged to the property owner and turned into the general fund. Also, there will be the usual engineering for sewer and water extensions, curbs and pavements. And finally, if the manager has charge of the street work, the street commissioner's salary may be added. The aggregate of these different amounts, if the town were doing its share of improvement work, would average from $100 to $150 per month, a sufficient amount to employ a competent engineer, without extra draft on the city's funds.

Economy at Abilene

To prove that this is not all theory let us consider the savings already made in Abilene, Kansas, a town of 5,000 population, which town has been controlled by commission form of government and an engineer-manager for the past eight months. During this time the following improvements have been made:

Street improvements	$80,000
Ornamental street light system, consisting of five-light and single-light concrete standards, cost of instalment, city's share	1,200
Light company's share	6,800
(The city has a contract with the light company to pay $3,000 a year for three hundred 40-watt lamps; about one-half of these are burned every night in the week, and the balance are burned about one-half the time.)	
Waterworks improvements, consisting of general overhauling and new pump at plant and booster pump	5,275
Water main extensions	2,910
Sewer extensions	2,136
Making a total of	$98,321

Later on there will be shown a few examples of savings as a result of proper management. Credit for these savings is given to the methods employed, such as: Preliminary estimates, which save the city from overcharges; plans and specifications, which insure better workmanship and speed; system; supervision and inspection, and a final measurement and estimate, which insure the city of fair settlement.

A summary of the several small sewer and water extensions exhibits the following marked differences. This takes into account work done by the old administration and that done by the commission body with a superintendent or manager. Somewhat different methods have been employed in the recent work. The city has purchased all of the material and let the labor to the lowest responsible bidder. All other conditions are practically the same. That is, cost of labor and material and all other features, such as depth of trenches, quality of soil, etc., are figured the same. The comparison is based on trenches averaging 8 ft. in depth, number one 6-inch vitrified sewer pipe, flushtanks and manholes built under the same identical circumstances.

Past methods show the following:

Excavating and refilling trenches averaging 8 ft. in depth	40.8 cts. ft.
Furnishing and laying 6-in. vitrified sewer pipe	15.5 cts. ft.
Furnishing material and building flushtanks	$66.00 each
Furnishing material and building manholes	$40.80 each

New methods:

Excavating and refilling trenches averaging 8 ft. in depth		25 cts. ft.
Laying 6-in. vitrified pipe	5 cts. ft.	
Furnishing on works 6-in. vitrified pipe	10 cts. ft.	
		15 cts. ft.
Labor on flushtanks	$10.00	
Material in flushtanks	41.80	
		$51.80 each
Labor on manholes	$ 8.00	
Material in manholes	15.00	
		$23.00 each

The saving is—in consideration of the amount done this year:

	Difference each item.
4,721 lin. ft. of excavation and refilling	$ 745.92
4,721 lin. ft. of furnishing and laying	212.44
3 flushtanks	42.60
4 manholes	71.20
Total amount saved	$1,072.16

on this one very small item of the city's business during the eight months of city management.

To save enumerating the total savings in the waterworks department I have figured that the difference between the unit costs under the old and new systems represents 8 cents per lineal foot and for the 5,010.0 ft. laid this year the saving would be $400.80.

The cost of cleaning the pavement and disposing was cut from an average of 40 cents per 1,000 sq. yds. to 36.2 cents per 1,000 sq. yds. Therefore on the total area of 2,215,797 sq. yds. covered in order to keep 92,000 sq. yds. clean for six months there was a saving of $842.00.

It would be too monotonous if I were to itemize every saving that has been accomplished by the more simplified form. However, in every department there has been a saving. The saving on the street cleaning was doubtles due to system. At present there is a report turned in by the street commissioner, showing the streets cleaned and the cost. From this report the number of sq. yds. is figured and the cost per 1,000 obtained. From this data different methods of cleaning have been tried until the most satisfactory method is obtained.

The dragging of dirt roads used to be considered too expensive and was therefore omitted. No one had any idea how many miles of dirt streets the town had which could be considered as arteries of traffic nor how much a mile the dragging should cost. In order to prove that all of the more important streets could be dragged at a nominal cost the streets were gone over and two districts were laid out. For each of these districts a logsheet was made, showing the streets to be covered, the number of times to cover each of them and the number of miles travelled. One district has 16½ miles to cover and the other contains 19 miles; when the streets need dragging teams are employed and each of the two outfits is paid $6 for following out the course as listed on his log. During the past eight months—of course some of these months were quite dry—the dragging has cost $51.

Now, besides the $2,315 which has been saved, as itemized here, the city has a complete set of records of all underground work and of every survey made.

In order that all important work shall be authorized by the commissioners as a body, with a clear understanding on their part, a report of the coming week's work is made up, with a preliminary estimate of the cost and an account of the benefits derived. This is presented by the manager at the meeting of the board and after the work is discussed the commissioners order that which they deem necessary. The manager then takes charge and at the next meeting of the board he reports on its progress; or if it is completed he submits the final estimate. With this procedure the commissioners are thoroughly acquainted with all of the city's affairs.

With all of the principles which have been discussed here and with the conclusive evidence of efficiency which has been cited as attained by the business-like methods which are possible in the engineer-manager plan there seems to be absolutely no question that it is the ideal form of public control, particularly for municipalities, and probably most applicable to the smaller towns while in its experimental state.

Proposed Aqueduct for Additional Water Supply of the City of Winnipeg

FROM time to time various details have been given in connection with the new water supply for the city of Winnipeg. Water is to be drawn from Shoal Lake and conducted to the city through an aqueduct more than ninety-five miles long. The design of this aqueduct is featured by Engineering and Contracting in an abstract from a report of the Board of Engineers, Messrs. Rudolph Hering, Frederick Stearns and Jas. H. Fuertes.

The new supply will be drawn from Shoal Lake, one of the lakes in the same group as the Lake of the Woods, and will be conducted to the city through an aqueduct of total length of 95.35 miles. The inlet to the aqueduct will be near the west end of Indian Bay, an arm of Shoal Lake. Leaving the lake the water will pass through a concrete aqueduct 84.75 miles in length, laid with a continuous down grade to a point about a mile east of Transcona, a suburb of Winnipeg, thence through a 5-ft. steel pipe line to the Red River, thence under the river through a 5-ft. cast iron pipe in tunnel, and thence through a 4-ft. cast iron pipe laid in the city streets, to the reservoirs at McPhillips Street. The concrete portion of the aqueduct will be given a capacity of 85,000,000 imp. gals. per day and the pipe line portion, 25,000,000 gals. per day. The construction of a 250,000,000-gal. reservoir at a point on the aqueduct about a mile east of Transcona is recommended, though not for immediate construction, and it is further recommended that a main pumping station be then established to force water to the city through the 5-ft. steel pipe. This reservoir and pumping station should be completed and ready for use before the demands for water have reached the capacity of the pipe line portion of the aqueduct.

The population of the Greater Winnipeg Water District is about 225,000, about 200,000 being in the city of Winnipeg. This population is twice that of seven years ago and five times that of 15 years ago. The average per capita consumption of water increased from 32 imp. gals. in 1902 to 47 gals. in 1912. The increase per capita is, of course, likely to continue with the increase in facilities for using water.

It is believed that 85 gals. per inhabitant is a proper quantity to adopt for estimating the future needs of the district as an average for the year, but in some months the rate will average as high as 100 gals. per inhabitant. Therefore an aqueduct to provide for a considerable time in the future should be designed with a capacity of 100 gals. per inhabitant, and even with this provision a large reservoir should be built near the city, in the future, to provide for a still higher rate of water consumption during short periods.

The consumption of water at the present time is somewhat restricted by the limited capacity of the sources of supply and will undoubtedly increase to a considerable extent when a new supply with a better water is furnished. For the next ten years, however, the consumption is likely to be less than 85 gals. per inhabitant.

The best conduit for conveying water for the greater part of the way from Shoal Lake to Winnipeg is a concrete aqueduct laid with a continuous down grade and as such a structure can be built of large capacity for a moderate additional cost, the engineers have designed this structure to carry 85,000,000 gals. in 24 hours, sufficient, on the basis assumed, for a supply throughout the year for 850,000 inhabitants. While this is a large provision for future years, it should be borne in mind that the additional cost of making such a structure of liberal size is comparatively small while the cost of duplicating such an aqueduct would be large.

The capacity of 85,000,000 gals. daily was adopted after giving due consideration to the many demands for money for public works in a growing city like Winnipeg; otherwise a larger aqueduct, say one having a capacity of 100,000,000 gals. in 24 hours would have been recommended.

From the point near Transcona where the concrete aqueduct ends, to the existing McPhillips Street reservoirs, a pipe is recommended; and a single pipe line of the sizes which now seem desirable will convey by gravity 25,000,000 gals. of water in 24 hours, or nearly three times the quantity of water now used. When necessary, the flow through this pipe can be increased by pumping, or a second pipe can be laid.

Assuming a continuous growth for the Greater Winnipeg Water District, based upon the past growth of the district and the rate at which other somewhat similarly situated cities have grown, the 85,000,000 gal. aqueduct would have sufficient capacity for supplying the district until 1944. Assuming further the introduction of water from Shoal Lake at the earliest practicable date, the aqueduct would supply the requirements of the district for about 25 years after its completion, and the 25,000,000-gal. pipe line would supply by gravity the quantity of water required for two or three years; but, as already stated, the capacity of the pipe line can be increased by pumping.

The Aqueduct

Intake.—The intake of the aqueduct is to be located at a corner of the bay where conditions are favorable in that the shore for a long distance is rocky, and the depth of water 50 feet from the shore is 10 ft. and 170 ft. from shore it is 15 ft.

It is proposed to build the gate and screen chamber on the shore and to protect the intake from material which may drift along the shore during winds, by building piers extending at least 150 ft. into the lake on each side of the intake, or by laying a large submerged conduit to bring the water from a point at least 150 ft. from the shore. The conduit is preferable, if it can be built for nearly the same cost as the piers. The bottom of the aqueduct at the bay is 11 ft. below high water.

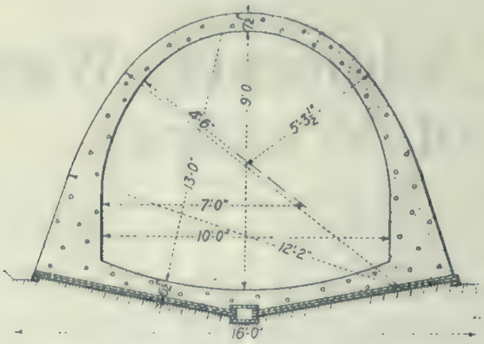


Fig. 1—Cross section of 9 x 10 ft. portion of proposed aqueduct for additional water supply of Winnipeg, Man.

Area of Section	73.6 sq. ft.
Perimeter	31.6 ft.
Hydraulic radius	2.33 ft.
Coefficient adapted	132.8
Concrete per lineal foot	1,156 cu. yds.

The gate and screen chamber should be designed with liberal areas for sluice gate openings and for screens, so as to cause as little fall of the water from the bay to the aqueduct as practicable. There should be at least two sluice gates not less than 5 ft. wide and 6 ft. high, and the screens should have a total length of not less than 50 ft. and a height extending from the bottom of the aqueduct to the surface of the water.

Aqueduct Designs.—In order to take water from Indian Bay by gravity, the aqueduct for the first nine miles has to pass through land that is higher than Indian Bay, thus necessitating a deep summit cut. After passing this nine miles, a line can be selected which will be down grade all the way to Transcona, but the gradient obtained for an aqueduct varies from place to place, and consequently the size of the aqueduct required to convey a given quantity of water also varies.

The engineers, therefore, prepared a series of designs of horseshoe-shaped aqueducts ranging from the large one, 9 ft. high and 10 ft. wide, used at the summit cut where there is a low gradient, here shown in Fig. 1, to one 5 ft. high and 5 ft. wide, used where the gradient is highest. Aqueducts of this kind are expected to flow partly full as a rule and never to have any considerable pressure of water against the top of the arch.

For the first 26,000 ft. of the concrete aqueduct, near Transcona, it is desirable to use a section which can stand internal pressure, as it will be necessary at some time in the future to build a large resrevoir at the end of the concrete aqueduct, in which the high water level may be 18 or 20 ft. above the surface of the ground and the aqueduct will be, at least in part, below the surface of the ground. This portion of the aqueduct has been designed of circular form, 8 ft. in diameter and provided with steel reinforcement. This pressure aqueduct will be equally valuable before the reservoir is built, as it will provide additional head at the end of the steel pipe to force the water through the pipe to the McPhillips Street reservoirs.

At the crossing of the Brokenhead River and the lowland each side of it, for a total distance of 13,000 ft., it has also been found desirable to adopt the circular form of aqueduct reinforced with steel so that this portion will withstand the pressure resulting from building it 10 ft. or more below the regular grade line.

As the aqueduct, with the exception of the reinforced portions above mentioned and some other short lengths at river crossings, is not expected to stand any considerable upward pressure on the arch, measures must be taken to prevent the opening of the sluice gates at Indian Bay to a height which will permit a quantity of water to enter the aqueduct much, if any, in excess of the rate of 25,000,000 gals. daily, which is the limit of the capacity of the pipe line leading from Transcona to the city reservoirs, and as a further safeguard waste weirs should be provided at several places where the aqueduct crosses streams to permit the water to overflow into such streams if it should rise above the safe elevation.

In order that the aqueduct may be both watertight, strong and permanent, it is recommended that it be built of first-class concrete mixed in the proportion of one part of Portland cement to two parts of sand and four parts of screened gravel. To prevent transverse cracks in the aqueduct, it should be built in sections not more than 20 ft. in length, and where one section joins another a steel bar about 3 inches by ¼-in. should be inserted to act as a water stop and prevent leakage at these joints, or some other suitable water stop should be provided.

The aqueduct cross-section shown in Fig. 1 has a central wooden box drain and a platform composed of two thicknesses of 1-in. boards, the upper one being fluted on the under side to furnish channels in which the water may flow from the side of the trench to the drain. The only purpose of this platform is to furnish a dry bottom upon which the concrete bottom of the aqueduct may be built and kept dry until it has had time to set. The dimensions of the box drain are shown in Fig. 2. All sections of the aqueduct may be provided with this platform.

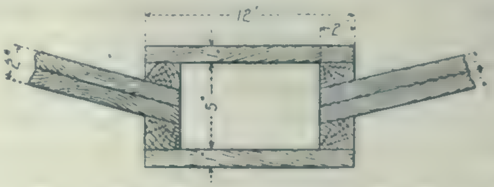


Fig. 2—Part section of box drain and timber foundation, Winnipeg aqueduct.

Although a double platform is shown it is better where there is but little water to be taken care of to use only one board with grooves in each edge of each board through which the water can pass to the central drain. Both types of plank foundation are shown in Fig. 3. The boards should be bedded in sand. If there are places along the line where a platform will not be kept continuously wet after the aqueduct is

Table 1—Lengths, Slopes, Elevations and Dimensions of the Various Sections of the Aqueduct from the McPhillips Street Reservoirs in Winnipeg to Shoal Lake.

Total Distance from McPhillips St. Reservoirs. Feet.	Miles.	Length of section, ft.	Dimen'ns of Aqueduct. Height, ft.	Width, ft.	Slope in ft. per 1,000 ft.	Elevation of hydraulic gradient at end of section, ft.	Remarks.
0	0	......	....	....	....	41.31	High water in McPhillips St. Reservoirs.
12,000	2.27	12,000	4 ft. diam.	C. I. pipe	0.81	51.03	These slopes and elevations are for a discharge through the pipes of 25,000,000 gals. daily.
56,100	10.62	44,100	5 ft. diam.	Steel pipe	0.37	67.35	
82,100	15.55	26,000	8 ft. diam.	Rein. conc.	0.025	68.00	
56,100	10.62	......	....	....	....	61.00	Proposed high water in reservoir east of Transcona.
82,100	15.55	......	8.0	8.0	0.29	68.54	This slope based on 85,000,000 gals. daily.
						Elevation of inside of aqueduct bottom at end of section.	
82,100	15.55	......	...	...	....	83.0	Beginning of grade conduit.
113,100	21.42	31,000	7.5	8.5	0.32	72.92	....
128,100	24.26	15,000	6.4	7.4	0.70	83.42	....
141,600	26.82	13,500	5.7	6.4	1.23	100.02	....
156,100	29.57	14,500	5.1	5.1	2.83	141.05	....
165,100	31.28	9,000	5.8	6.7	1.00	150.05	....
229,700	43.54	*64,600	6.6	7.6	0.54	184.93	....
246,500	46.69	16,800	5.3	5.7	1.90	216.90	....
262,500	49.71	16,000	6.7	7.7	0.50	224.90	....
306,500	58.65	44,000	7.4	8.4	0.30	238.10	....
392,500	74.34	86,000	6.3	7.3	0.69	297.44	....
445,400	84.35	52,900	7.3	8.3	0.32	314.37	....
455,400	86.25	10,000	8.0	9.0	0.24	316.77	....
470,400	89.09	15,000	9.0	10.0	0.24	320.37	....
503,359	95.34	32,959	9.0	10.0	0.11	324.00	....
503,400	95.35	41	...	....	0.00	324.00	Gate and screen chamber.

*13,000 ft. of this length at Brokenhead River Crossing is 7.2 ft. in diameter and reinforced.

completed, the platform should be omitted because of the liability to decay under such circumstances.

Re-filling and Embankment.—Where pipes are to be laid in the streets, they are to be placed at a depth which will permit a 4-ft. covering of earth. East of Transcona, where the aqueduct will not follow the streets, but be laid through the open country, the much cheaper and more expeditious plan will be adopted of building the aqueduct in a shallow trench—from 3 to 4 ft. deep, where practicable—and covering it to a depth of 4 ft. with an embankment of earth.

It is proposed to make this embankment with a top width of not less than 8 ft. and nowhere less than the inside width of the aqueduct and to make the slopes of the embankment 2 horizontal to 1 vertical.

Aqueduct Statistics.—Table 1 gives various statistics relating to the different portions of the aqueduct, including the lengths, gradients, elevations and dimensions of the different portions.

For a distance of 33,000 ft. from Indian Bay, the gradient of the aqueduct has been made only 11 ft. in 1,000 ft. This low gradient was adopted to diminish the depth of the summit cut. The aqueduct through this section is 9 ft. high and 10 ft. wide.

For the next 25,000 ft. the fall per 1,000 is .25 ft. The large sized aqueduct, 9 ft. high and 10 ft. wide, is continued for 15,000 ft. of this distance and a smaller aqueduct, 8 ft. high and 9 ft. wide, for the remainder of the distance. This design is the result of somewhat complicated hydraulic computations which show that with these sections of the aqueduct as planned 85,000,000 gals. daily will flow through the aqueduct when the water in the bay is 3.75 ft. below high water level, provided the water has such a free entrance through the intake and gate and screen chamber that it does not fall more than .25 ft. in passing through them.

Beyond the three portions of aqueduct above described, the gradient of the aqueduct has been made to follow approximately parallel with the surface of the ground all the way to its end near Transcona, and a size has been adopted for each gradient, with a few exceptions which would give the aqueduct the standard capacity of 85,000,000 gals. per day.

The quantity of water which will flow through the reinforced section of aqueduct, used for the last 26,000 ft., will not depend upon the gradient of the aqueduct itself, but upon the hydraulic gradient available when a reservoir is built east of Transcona, and its size has been computed accordingly.

Somewhat similarly, the next two portions of the aqueduct east of the reinforced portion, covering a total length of 46,000 ft., have been made a little larger than the size due to the gradient of these portions, on account of the possible back water effect from the reservoir.

The flow through the pipe line is, of course, dependent upon the hydraulic gradient and not upon the gradient of the pipes. For a flow of 25,000,000 gals. daily, this amounts to .37 ft. per 1,000 in the 5-ft. pipe and .81 ft. per 1,000 in the 4-ft. pipe, making a total fall through these pipes to the McPhillips Street reservoirs of 26 ft.

Red River Crossing.—The design provide for crossing Red River with a pipe placed in a tunnel, the tunnel extending about 900 ft. horizontally across the river from a shaft in Victoria Park to a corresponding shaft on the opposite side of the river. The shafts will each be about 75 ft. deep. After considering different plans, one plan was selected which provides for the use of cast-iron pipes 5 ft. in diameter, with metal 1.9 in. thick, provided with a special bell about 15 in. long, so designed as to permit the joint between pipes to be caulked from the inside with lead wool. The tunnel is to be excavated only large enough to permit the pipe to be put in place. This requires that its minimum diameter shall not be less than 6 ft. 3 in. and the average diameter, owing to the irregularities in blasting, will be considerably more. All spaces between the pipe and the sides of the tunnel are to be filled with concrete, as far as it is practicable to place concrete, and the remaining space is to be filled by pumping in cement grout, the aim in using such thick pipe and in filling all spaces with concrete or cement grout being to make absolutely secure this portion of the pipe line which will be inaccessible unless the water is shut off and the pipe is emptied by pumping.

Seine River Crossing.—The pipe where it crosses the Seine River is located in a proposed street, and the designs provide for building a 30-ft. arched concrete culvert, filling over it with earth and laying the steel pipe in the earth in the same manner as in the other places.

Other Special Structures Along Aqueduct.—In addition to the intake works at Indian Bay, special construction and structures will be required at various places. At the crossing of the Falcon River a pile foundation will be required for about 600 ft., and for about 150 ft. of this length it will be necessary to depress the aqueduct so that its top will be low enough to permit the passage of the water of the river and of boats of light draft. This depressed portion should be reinforced with steel, and the concrete should be made much thicker than under ordinary circumstances. In a similar way there should be a depressed and strengthened section of aqueduct at the crossing of the Whitemouth and Brokenhead Rivers, also at the Birch River, unless it is found to be feasible to carry the aqueduct over the river. For a part of the distance at the crossing of the Brokenhead River, where the muskeg is too deep to permit of the construction of the aqueduct upon a solid natural bottom, a pile and timber foundation will be required.

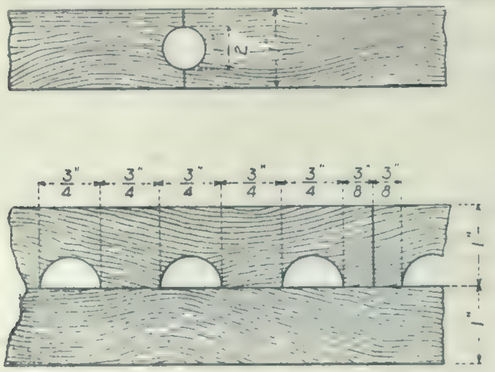


Fig. 3—Detail section of plank foundations where one and two thicknesses are required—Winnipeg acqueduct.

Blow-offs should be provided for discharging water from the aqueduct into Boggy, Birch, Whitemouth, Brokenhead and Red Rivers and into other places where an opportunity offers, such blow-offs being convenient for use during the construction of the aqueduct and while it is being cleaned or repaired and for use in emergencies when the aqueduct is in service.

Waste weirs should be provided at the Birch, Whitemouth and Brokenhead Rivers and provision should be made at these waste weir structures for placing stop planks across the aqueduct to stop or throttle the flow through it. By making suitable arrangements, it will be practicable to force over the waste weirs any excess of water above the capacity of the pipe line leading from Transcona to the city which might accidentally be permitted to enter the aqueduct at Indian Bay.

Culverts will be required where all small streams cross the aqueduct line and at other places where there are no definite streams, in order to permit water to find its way from one side of the aqueduct to the other. All culverts should be so designed that they will not become plugged by ice during the winter.

Permanence of Concrete Masonry

Concrete masonry is under most circumstances one of the most durable and permanent of materials, but in certain soils and in the presence of sulphates and sulphuretted hydrogen it sometimes softens and disintegrates. Even under these adverse circumstances it has been found that a dense, smooth and impervious concrete is very resistent to deterioration.

In order to ascertain whether or not any deterioration of the concrete of the proposed aqueduct is likely to take place, the engineers had certain chemical analyses made of the muskeg waters, the materials forming the muskegs and the underlying soils, both in the Laurentian formation, which underlies the greater part of the length of the aqueduct, and limestone formation which occurs towards its westerly end. The results of these analyses show that the sulphates and sulphuretted hydrogen were not present in the Laurentian formation, and were there only in small quantities, in the limestone.

As already stated the policy adopted provides for building the aqueduct, where possible, in a shallow trench from 3 to 4 ft. deep. This method of construction will permit of the drainage of the muskegs and other ground in the limstone formation, nearly as low as to the bottom of the aqueduct, so that very little of the ground water, which may contain sulphates and sulphuretted hydrogen, will come in contact with the concrete, and the engineers recommend that especial attention be given to providing good drainage along the aqueduct through the limestone formation.

Although the engineers believe that with concrete mixed in the usual proportions there would be very little danger of disintegration they have thought it best to recommend that the concrete be made of such proportions of cement and other materials that it will be especially dense and strong, and therefore much less likely to be injuriously affected.

They are convinced that the concrete aqueduct, if built as recommended, will be a permanent structure.

With the improvements which have changed the Selkirk road, in Manitoba, from an often-impassible track to a fine highway, the Manitoba Government inaugurated a policy which has for its aim the improvement of roads throughout the province. A capital expenditure of $2,500,000 will be laid out in road work in the province during the next few years.

A new method of constructing ferro-concrete hollow walls has been invented, which is claimed to be efficient and economical. The wall, which can be made in any thickness from 5 inches upwards, is formed of slabs 36 x 12 x 2 inches, cast with a dovetailed vertical point. When the slabs are being built, as in the manner of ordinary partition slab work, a ferro-concrete post is built up at the same time between the two walls, these posts having 36-in. centers. The forming of the post simultaneously fills the vertical dovetail in the slab, which thereby becomes part of the post and rigidly ties the two slab walls together. The steel of the posts is anchored into the foundation, and is carried into the beam on top, thereby giving the same value as in situ panel construction without the disadvantage due to contraction.—Engineering-Contracting.

Fundamentals of an Extended Experience in Sewage Disposal

WHAT may be termed the fundamentals of sewage disposal were considered by Dr. Bostock Hill, Medical Officer of Health for Warwickshire, Eng., in his presidential address to the Association of Managers of Sewage Disposal Works. The portions of Dr. Hill's address abstracted below was prefaced by a brief reference to the earliest work in this field and by a few observations on the subject of land treatment. In our abstract we have endeavored to present such features of general interest as may be suggestive in Canadian practice.

Preliminary Treatment

It is rare, except in the case of very small communities, for any new scheme of sewage purification to be a land scheme, and so I propose to leave this matter and deal with my experience generally on the various types of treatment in use called bacterial installations. I think we may take it that in the great majority of schemes at the present time the sewage is first of all screened, and afterwards subjected to so-called septic tank treatment. As I have previously stated, we have given up the idea of complete resolution of the organic solids. Not only have we done that, but I think that if we have learned anything of late as regards this preliminary septic treatment, it is that it is extremely desirable to prevent the septicity being carried too far. To a large extent, of course, this depends on the nature of the sewage, and in what I say now I am supposing the sewage to be an average one, consisting, chiefly, of ordinary domestic sewage and refuse. Special cases must, of course, be specially dealt with. It used to be taken as a somewhat general rule that the time sewage remained in the septic tank to undergo its first process was twenty-four hours; but I have definitely come to the conclusion that it is desirable, in the majority of cases at least, to reduce this period considerably, and for a theoretical standard installation I should be inclined, at the present time, to reduce the period of septic action to twelve or fourteen hours. I do not make this suggestion on the ground that nuisance may result to those around from the septic tanks, though this is a question which may have to be taken into consideration, but I refer solely to the production at the works of a good effluent, and I am sure at the present time many managers of works have difficulties to contend with owing to "over-septic" treatment.

Another point which is, I am sure, of great importance, which, of course, has been dealt with, but which has come prominently before my own personal notice, is that of the amount of suspended solids discharged on to the filters. I am not going to touch upon the question of colloidal matter, but I do definitely state that unless the amount of suspended solids are kept down to something approaching 8 or 10 grains per gallon reasonably good results will not be consistently maintained. This practically requires, therefore, that septic tanks must be cleaned out comparatively often, and not left, as was at one time done, as long as possible in order that the resolving action should be maintained as efficiently as possible.

Filters

Next I would come to the filter. I cannot help but be struck by the enormous amount of literature that has been given to the world on this point. My earliest experiments were with coal as a medium, and here I would mention that I still say what I affirmed nearly twenty years ago, that if it were possible to obtain coal at a price which would compare with other media, no medium is so completely satisfactory as this one. The price of coal, however, of late has risen to such a figure that its use has become an impossibility, and fortunate for us it is—though I still believe coal, when properly used, to be the best of all media—we have plenty of others at our call from which excellent results can be obtained. The question as to what medium should be used in a particular filter depends chiefly on which of the available suitable materials can be the more easily obtained. Slag, clinker, granite, slate and other materials are all quite suitable, though I consider care must be taken in the choice of slag to see that no substance is yielded when treated with sewage that tends to seriously affect the effluent subsequently.

Having regard to modern methods of distribution, I have come to the conclusion that if there is no reason to the contrary, the circular filter is undoubtedly the best, chiefly on the ground that regular, systematic distribution is the more easily obtained.

As regards the amount of available material in the filters, my experience tells me that it is not merely a question of the number of cubic yards available. With a full knowledge of what has been done in a great many places, I am strongly of opinion that there should be a distinct relation between the area and the depth. I admit, perfectly freely, that good results are obtained from filters of very varying depth, but I am equally sure that, under normal conditions, the filter should not be too deep nor too shallow. I am not going to hide behind any such generality as the last sentence suggests. If it be necessary for a filter to have a certain surface area, and if it be made deeper than necessary to effect its purpose, obviously there is a waste of material and an unnecessary increase in its cost. It has been the custom of late to estimate the amount of available material in cubic yards. Personally, I object to this method, though it be official. I am quite convinced that a too shallow filter is not sufficiently effective, however fine the material may be. I do not think we have sufficiently yet taken into consideration the atmospheres of the filters, and I have come to the conclusion—as a result of experiment—that filters under 4 ft. deep are not completely satisfactory. In other words, I do not consider an equally good result can be produced by diminishing the depth and increasing the surface, except within somewhat narrow limits. I have carried out experiments at different works in tapping filters down to 7 ft., and as a result of these experiments, carried out for a series of years, I consider that with normal sewage the standard depth of filter should be 5 ft. Nobody has a higher appreciation of the magnificent work done in the interests of sewage disposal by my friend and colleague Dr. George Reid than I have. We have worked together for many years—more than either of us care to remember—and of all the difficulties and problems which have arisen, in only one, as far as I know, do we not see eye to eye with each other. He has been—of late years at all events—an avocate of the shallow filter. While not being an advocate of the deep filter, I am convinced that under normal conditions the best results are obtainable in one of medium depth. I am quite conversant with the splendid attainments at Hanley and some other places in Staffordshire. My knowledge of the work is not superficial. For a period of over twelve months I analysed the Hanley sewages and effluents monthly, and I know therefore what results are constantly obtained there, but with this knowledge, in the light of information I have of other sewages, I say that while the results obtained at Hanley are consistently good, the same results could not be definitely and certainly attained under like conditions in the majority of other places. The conditions in North Staffordshire are peculiar; the sewage is more or less weak, and there are other physical conditions of the sewage which make for purification, and thus permit of less work being done by the filters to achieve a thoroughly satisfactory effluent.

As regards the size of the particles of medium, I have come also to very definite conclusions. My first experience of biological filters was made with coal, and here the particles used were extremely fine, going down to 1-16 in. As a result, however, of further experience with media other than coal, I am inclined to think that, taking average sewages with a filter 5 ft. in depth, probably the best average results are obtained with a medium the particles of which are about ½ in. in size—perhaps with a little finer material on the top. I have satisfied myself that, under ordinary conditions, such a filter will last for a very long time without any diminution of its powers of taking and purifying sewage. I have also satisfied myself that one of the causes of trouble in fine grain filters is that the material often contains finer particles than those specified, and I have had experience of trouble arising from this cause. An ordinary streaming filter is, to my mind, best graded to some slight extent—namely, a few inches of larger particles at the bottom, these followed by particles reaching ¾ in., the bulk of the filter, however, being of ½-in. particles. I am quite aware that my friend Mr. Watson, whom I acclaim as one of the leading authorities on sewage treatment in the world, does not quite agree with me. I remember his telling me once, when he was putting down the large acreage of beds for the Tame and Rea Drainage Board, that with so large an area he would not sleep in his bed of a night if he felt there was a danger of the filters choking up. I sympathise with his fear, but I do not agree with the risk that he imagines. Personally, I have satisfied myself through a long series of years that, given reasonable precautions, such as may now be said to be standardised, there is no more danger of a small grain filter than of a large grain filter becoming occluded by sewage. Some experiments carried out by Dr. Reid, in fact, point quite in another direction, and though I have under my supervision a very large number of filters with fine medium, I have never seen any more danger than in the case of the filters in which the particles are large.

As regards the quality of the effluent, in my experience there is no comparison between the two; if, however, it be desired to treat on a filter a larger quantity of sewage than the filter should be required to take, then I admit that apparently a better result is obtained, and possibly, under some circumstances, a sufficiently good result, taking into consideration the requirements of the district.

Final Effluent Treatment

A point which has struck me in my own personal experience is the value of running effluent into large shallow lagoons before discharge into the streams. It always seems to me that, where circumstances permit, this is a very desirable procedure.

If the medium of which the filter consists is formed of large particles, humus tanks are undoubtedly absolutely necessary, while I am inclined to think that, even in the case of fine grain filters, where the sewage is strong, the institution of such tanks is distinctly advantageous. In many places where the effluent is otherwise excellent in character—that is, nonputrescent and well oxidised—it may then be found containing at certain times of the year 5, 10, 15, or more parts per 100,000 of suspended matter. I have hardly seen any case where this could not be materially reduced, almost if not quite, to the figure suggested by the Royal Commission, by suitably constructed humus tanks.

A word or two as to distribution. I have before stated that Mr. Garfield and myself instituted the first streaming filter with mechanical distributor—a form of spray. This, of course, was long before the days of the present satisfactory mechanical distributor. Let me say, however, that I am by no means in favour of sprays. They were valuable as a stage in the evolution of scientific sewage treatment, but I consider their day has passed. The Royal Commission apparently are in favour of mechanically driven distributors, and no doubt very excellent results can be obtained by these; but, on the other hand, the experience of the last ten years is conclusive to my mind that such distributors are by no means essential. Good results can be obtained wtih a minimum of nuisance or smell, which need not extend beyond the works, by ordinary distributors, supposing the scheme be a properly designed one.

Tests and Standards

Another point which has come prominently under my notice is the question of the testing of the quality of effluents as discharged in a county where much sewage work has been done, and where many samples are obtained each quarter, a vast amount of experience has collected, and suffice it to say that even before the Report of the Royal Commission expressing its opinion as to the tests which should be applied to effluents, I have myself become perfectly satisfied with tests previously available. I carried out, at the request of the Royal Commission, a series of tests for dissolved oxygen in effluents. With care and experience I believe that such tests may be applied with a fair degree of accuracy; but, after allowing this, it seems to me that the nature of the test is such that it can hardly be considered applicable for the use of the sewage manager under ordinary conditions. Neither do I think that the results obtained are commensurate with the difficulties and time taken up by the test. Personally, I am perfectly content to form my opinion as to the polluting character or otherwise of an effluent by the amount of suspended matter in it, the amount of oxygen absorbed in four hours, and the quantity of nitric nitrogen. I am also in the habit of carrying out incubation experiments, and of estimating the free and organic ammonias; but though these are useful, and no doubt afford a certain amount of additional information, the three tests I previously mentioned, speedily and easily applied as they are, appear to me to be the most applicable for general use. But in judging of the character of an effluent, what we have now to consider largely is the question whether or not the amenities of those living near or having rights in the stream are respected, and the very simple test, applicable in nearly every instance, of allowing the effluent to flow in and out of a tank in which ordinary coarse fish are kept, is, in my opinion, one of the best, and at the same time an object lesson to the public. In many of the works I supervise this fish test is carried out. If the fish remain for months alive and well, obviously there is nothing passing into the stream which is likely to be fatal to fish life, while if anything happens to them the daily inspection of the fish tank will in itself be an intimation that the matter requires investigation.

Nuisances From Sewage Works

In addition to the works with which I have been associated for the purification of sewage, it has been my lot to have been engaged in a considerable number of actions at law in reference to nuisances from sewage works. In the pre-bacterial days many actions took place on the ground that nuisance was caused by sewage farms to residents in the neighbourhood, and when this was so, it was nearly always due to the neglect of some reasonable precautions in the reception of the sewage, or with the way it was dealt with on land. In the case of normal sewage, nuisance rarely occurred unless the land was unsuitable in itself, or the sewage was applied in such a way that lagoons of crude sewage were formed, which, in hot weather, gave rise to nuisance.

When bacterial installations first came into vogue it was felt that the septic tank might be a nuisance, and care was taken in the early installations to cover such tanks completely in. In fact, it was laid down that the covering in of the tanks was almost a necessity. Later, however, it was found that, except under special circumstances, where such tanks were close to buildings, this precaution was unnecessary; but for all that, troubles even of late have still arisen under special circumstances. In the hot year of 1911, when the temperature in the middle of the summer was very high for many days, conditions arose which produced nuisance under many circumstances hitherto unsuspected. Similar conditions have arisen in cases where the sewage to be treated is of a special character; for instance, when it contains much brewery, tannery or fellmongers' waste. In the case of the huge installation of the Birmingham, Tame and Rea Drainage Board, a serious nuisance occurred for a long distance around the works in the summer of 1911, and this required special treatment in deodorising the sewage so that nuisance might be avoided. Difficulties have also occurred at Stratford-on-Avon, Nuneaton and several other places, and it has been found necessary under these special circumstances, whether of character of the sewage or meteorological conditions, at times to deal with the sewage to prevent undue putrefaction. Mr. Watson, at Birmingham, found that a minute quantity of hypochlorite should be added to the sewage, which would prevent the nuisance arising from the fifty or sixty acres of sewage bed without in any way interfering with the bacterial treatment of the sewage.

It is obvious that when a new state of conditions comes into operation, unexpected difficulties will arise, and I quote these cases as evidence of the amount of skill and experience necessary in those having to deal with such works.

Difficulties in Treatment

I may also mention here two interesting cases which came under my observation of unexpected difficulties occurring in bacterial installations in rural districts. A bacterial plant was laid down, and dealt quite effectively with the sewage of the community. In a short time, however, a new gasworks was laid down in the rural district for the supply of a neighbouring city. The waste waters from this gasworks were turned into the sewers, and in a very short time after the works were opened the beds were absolutely and completely sterilised. Efforts were made to so deal with the waste that its deleterious effects could be neutralised, but with no effect, and the waste gas washings had to be taken from the sewer and diverted elsewhere, when, in course of time, the efficiency of the beds was restored. In another case, a most excellent works, up to date in all respects, received, at times, waste from a large tannery, with the result that, despite effective tank treatment, so much animal solid matter got on to the beds that they were rendered useless. Here, again, by dealing specially with the waste matters before discharge into the sewer, the efficacy of the plant again became normal.

Necessity for Extensions

When a local authority has spent a considerable sum of money in laying down a plant for dealing with sewage, and both the members of the body and others concerned are satisfied with the results produced, it is extremely difficult, I have found, to get the body to understand that if a rapid increase of population takes place a corresponding increase in the means of purification must also be effected. Even with every desire to do what is necessary, local authorities are apt to allow their plant to become somewhat ineffective, by not taking steps sufficiently early to increase its power as required. I know of a city whose population increased in fifteen years from 58,000 to over 100,000. The sewage works were originally well adapted for their purpose, and did excellent work. Though extensions were made, they were not made as fast as the increase of population occurred, with the result that the continued deterioration of the effluent and of the river into which it flowed became marked. Nothing is so uneconomical as overwork, whether it be of the individual or of a scientific plant, and it is important for all those connected with sewage works management to be ready to grasp the situation and advise as to the importance of extensions being made before they are proved to be absolutely necessary. Before I pass away from this part of the subject I should just like to call attention to one other matter. That is, though we now generally understand the purification of sewage to be due to biological processes, we are still apt to consider that the forces at work are chiefly micro-organisms. The work, however, which has been done by some of the members of this society—and particularly Mr. Bell's work on "the influence of podura on the efficiency of action of filters"—is so marked and so important that in any resume brought up to date it should not be left without mention.

Importance of Good Management

An important point is that of good management. In a recent report I called attention to the management of sewage works, and stated as follows: "Every year I supervise the work of sewage disposal plant I become more imbued with the idea that the crux of the matter is the question on management. Works constructed in the most scientific manner, with every up-to-date appliance, will, if not efficiently managed, frequently become ineffectual; while, on the other hand, given good management, a small area of land, or secondary bacterial installation will often produce a good result. It is very unfortunate that many bodies do not grasp this fact. They spend considerable sums in laying down works, and appear to think that these should go on automatically. As a matter of fact, much expense is entailed by forgetting that management is equally important with good construction of works. It is obvious that scientifically designed plant cannot be with safety left to a labourer; and yet in some instances I have known this to be done, and works originally well designed be blamed for the unsatisfactory results obtained."

As in the case of human beings, what is continually sought for is the "mens sana in corpore sano," so the ideal for reaching the best result in a sewage works should be the attaining of the scientifically constructed works, dealt with by a conscientious and well-skilled manager.

The Thirty-Fourth Annual Meeting of the American Waterworks Association is to be held in Philadelphia, Pa., May 11 to 15 next. Particulars of the meeting may be obtained from the Secretary, Mr. J. M. Devon, Troy, N.Y.

The next issue of the Contract Record and Engineering Review (March 5) will contain a report of the annual convention of the Ontario Good Roads Association, which is now being held (February 24 to 26) at the York County headquarters, 57 Adelaide Street East.

Messrs. Langman & Williams, architects, have opened an office at 194 Carlton street, Toronto. The partners are Mr. Percy Langman and Mr. E. J. Williams. The former was associated for some time with the Provincial Works Department at Toronto and at an earlier date with Messrs. Langley & Howland, while Mr. Williams has been with the Dominion Realty Company and the Hydro-electric Commission.

Problems of the Waterproofing Engineer

Why Concrete Needs to be Waterproofed—Up-to-date Methods Discussed —Decoration of Exterior Concrete Walls and Treatment of Cement Floors

Contributed by Wm. H. Evans[*]

IT is surprising how many engaged constructively in the building world are unfamiliar with the up-to-date methods of decorating and waterproofing concrete structures, and because of their unfamiliarity in many cases have pasted concrete up. There are many reasons for placing concrete ahead of any other building material, but the writer will only dwell on the three above-mentioned subjects.

In the issue of the Contract Record for February 11, Mr. Gresser contributed a lengthy article on the same subject. As several of his statements were very strong and to my mind (unintentionally) misleading, I am forced as a practical waterproofing engineer to write this article pointing out to those who have read his contribution the other side of the story. I trust that readers as well as Mr. Gresser will carefully consider my arguments.

His introductory remarks were correct. Cement construction does require great care. Unfortunately the impression has gone abroad that it requires only unskilled labor to erect concrete structures. That ordinary laborers are used in concrete work, while in brick structures high-priced bricklayers would be required, is quite true, but the real difference comes in where the superintendent is concerned. The man in charge of a bricklaying crew owes his position to his success in getting work out of his men, which is all that is required of him, as the materials are of such a nature that all they require is careful laying-up to develop their entire strength. Such a foreman would be absolutely worthless in charge of concrete work, for his "hurry up" methods are not conducive to the best results.

There is nothing problematic about the strength of good concrete any more than there is about the strength of brick or stone. The only trouble is that we must assume the work will be well done, and this only good, intelligent supervision will accomplish. If the work is not properly done, or if through ignorance or carelessness poor materials lacking in strength are used, the concrete will be brought to naught, just the same as if sun-dried bricks were used instead of granite, or wooden beams were substituted for steel girders. It is in the construction end of the building wherein the greatest responsibility lies, and here the utmost experience and skilled supervision is needed; in fact one poor batch of concrete might mean disaster to a structure.

Many arguments have been raised against waterproofing compounds and liquids. It is a recognized fact throughout the entire construction world that materials which are to enter a structure under the process of erection should be tested. Waterproofing, probably more than any other material, demands this attention. First, because as a matter of fact there are so few who really know what the results of the conditions imposed will be. Second, because of the wide variation in the many brands of waterproofings, and even between the different batches of the same brand. Third, because there are still on the market a few unscrupulous dealers who are not as careful of the products they put on the market as they might be.

Architects and engineers, as well as the public, may be pardoned if they have failed to realize the wide influence which has been exerted in recent years by the leading waterproofing companies, not only in matters relating to their specifications, but also in the development of ideas for the safety, help and comfort of the public. Their failure to realize may be easily explained. On the market at the present time are hundreds of brands of waterproofing, all claiming to be the right one, with prices ranging from four cents to fifteen cents per pound. The practice of most manufacturers apparently is to sell their products, get all there is in it, and get out with their profits before their products have had a chance to fail. Architects, engineers and the public have been stung so often that they have become sceptical, with the result that the real ones have had hard times in gaining recognition. We take issue with Mr. Gresser in his statements that waterproofings, compounds or liquids, when added to the cement will weaken the mass and cause it to deteriorate and affect the re-inforcing. Mr. Gresser was probably referring to the less reliable brands of waterproofing, because I can prove to him and readers of the Contract Record that there are waterproofing compounds that have been put on the market after years of research work, that will waterproof concrete absolutely, and instead of causing the concrete to deteriorate will increase the tensile strength. The result is imperishable concrete structures.

The part that cement plays in concrete construction is the most important one. Its work starts when the water is added, and it plays the part of a medium for uniting cohesively and adhesively members of masonry and aggregates of concrete, but it is not capable of carrying its part and, therefore, must have an assistant, because the value of Portland cement as a medium for uniting cohesively and adhesively members of masonry and aggregates of concrete lies wholly with its colloids. These latter are the glues or jelly-like crystalizing properties that are contained in the substance of the cement clinker, and which are set free by the water. As this is insufficient to secure impermeability, it is the cause of the more or less common belief that Portland cements are incapable, by themselves of producing non-porous, waterproof and damp-proof work. If we look around us we will see the truth of this, wherein as already stated, the value of Portland cement lies wholly with its colloids; and as the cement does not contain sufficient colloids to secure waterproof concrete, we will have to call to its aid a mineral substance in a true colloid composition, which when added to the cement will produce perfect water-tight concrete construction. The mineral substance will have to be in the form of a waterproofing material. It may take some time for this idea to fasten itself upon the minds of those who are engaged constructively, but in the end it will be obvious for those who have followed cement waterproofing from its inception know that a chemical must be added to the cement that will assemble the aggregates into a dense body before it is waterproof.

---

[*] Consulting Waterproofing Engineer, Montreal.

A great many are under the impression that only cheap construction needs waterproofing, and that the use of high-grade materials and workmanship will assure water-tight results. The results are produced by such methods in just enough cases to give some color to the theory that this method is a safe one, but investigation of any considerable number of such instances will show clearly that the waterproof result is the exception and not the rule. Having proved that waterproofing precautions are necessary, the next question is the method of waterproofing to be used. There are two methods of attacking the problem. The membrane method which derives its name from the manner in which the continuous elastic, impervious sheet of bituminous material or patent compound surrounds the structure to be waterproofed. The materials used for this form of waterproofing are coal-tar pitch, asphalts, asphalt mastic and specially-prepared compounds. The pitch and asphalt are applied hot in the majority of cases, and where severe conditions are to be provided for, layers of felt or burlap are used with the preparations, and as many as seven layers. For the exclusion of ordinary dampness two or more coats of the preparation without the felt may be used directly upon the surface to be protected.

The membrane method is easily injured during construction. If punctured by accident, or disintegration later by the earth fluids, water is likely to penetrate the wall many feet distant from the actual break, and the membrane can practically never be reached and repaired. The membrane method calls, in some cases, for expensive protective or retaining walls, requiring additional excavation and taking up valuable space. All this is unnecessary where an integral or a waterproof cement facing is used.

The integral method takes its name from the meaning of the word, the waterproofing material becoming part of the whole, and the entire mass of concrete or mortar being affected throughout, as distinguished from the use of a separate and individual protective coating. The effect desired is produced by properly grading the aggregates themselves and then adding special preparations in the form of liquids, pastes or powders, either to the water used in mixing the concrete or to the cement before wetting. A further extension of the integral method might include the application of waterproofed mortars to ordinary mass work, where the mortar coating becomes an inseparable part of the mass. It must not be surmised that an integral waterproofing material will make a poor or lean grade of concrete waterproof, although it may serve to render it less susceptible to ordinary dampness.

The success or failure of any firm, and their plans and reputation, depend more on the people entrusted with their work. To entrust waterproof work to common laborers under the impression that it is rough work anybody can do, is to invite failure.

Waterproofing is usually an engineering problem required patience and painstaking methods, without which no system has ever been able to effect reliable results, yet any experienced cement worker can perform the work if he will use his head with his hands, and will stand for nothing short of thoroughness in the preparation of his surfaces, selection of ingredients and in the workmanship. Several of the reliable manufacturers will take your contract to waterproof, damp-proof, decorate the concrete walls for waterproofing, treat cement floors for dustproofing. As an alternative they will send one of their engineers who is well-trained on the subject to supervise the work at normal cost where the work is not done by them, and in both cases will guarantee the work, which proves their faith in their materials. Many are under the impression that their buildings do not require waterproofing above grade, especially concrete buildings. To this I will reply that when concrete breaks down, (in the majority of cases it happens in the winter and spring), this is due to the fact that concrete absorbs moisture which freezes and expands, then it thaws and the obvious result is a disintegration of the concrete, frequent crumbling and the appearance of large cracks as the water forces itself to the surface. This is especially true in retaining walls, abutments, etc. It also explains why the interior of buildings is frequently damp, even when built of hollow-tile blocks. The reason why concrete sub-structure walls hold better than elsewhere is because the walls are below grade. The water may seep through these walls without materially injuring the concrete because it does not freeze.

Conditions to Provide for in use of Porous Materials

In the use of porous building materials there may be two conditions to be provided for in keeping out water or dampness. First, water pressure to be resisted, and actual entrance or percolation of water prevented. Second, a gradual absorption of water by the materials, due to porosity and capillary attraction. While water may not seem to be present in the material upon inspection of visible surfaces, it is nevertheless present and is being constantly evaporated away from the surfaces in contact with moving air. A concrete wall may give out dampness to a room even if the material is of such a nature that percolation of water through the wall does not actually take place. Provision against the first of these conditions is comonly referred to as "waterproofing," while protection in the second condition is called "damp-proofing." While on the subject of waterproofing as it pertains to concrete I will cite the precaution necessary to make the structure sanitary, dry and a healthy place in which to work or live. Possibly the first consideration should be that of the location in which you are going to build. It goes without saying that if we dig a hole in low ground, the hole will fill with water, either when dug or after the first spell of wet weather.

A cellar placed in a similar location would be subjected to the action of water varying from a perceptible water pressure down to ordinary dampness, depending upon the ability of the surrounding earth to carry away the water. Such a cellar should be provided with integral waterproofed concrete walls and floor, in such a manner that water will neither enter the cellar nor be transmitted to the building walls above. The side walls of the building above grade should be constructed in such a manner that water from storms will not be absorbed and pass through into the interior of the building. This can be done by applying two heavy coats of a damp-resisting paint of such a nature that when applied it will remain tacky and form a perfect bond for the plaster.

Whenever moisture penetrates a piece of reinforced concrete, the corrosion of the reinforcing member is absolutely certain to result, and the corrosion once established contains within itself the elements of an unending existence while moisture is present. Then follows the breaking of the bond between the metal and the concrete, the weakening of the structure, cracked and sagging floors, insecure dams, unsafe retaining walls and general decay. Concrete has come to stay, and waterproofed concrete is the best method of construction ever devised by man; it is fireproof, sanitary and practically indestructible.

There is only one way to do a thing right, and that is to do it right from the beginning. Work, worry and repair may make a bad job better, but they never made a bad job good.

It is especially true in concrete construction, where the work was apparently well done, the mixture was right and the weather conditions ideal to produce a lasting, permanent concrete structure, and yet within a few years the structure or retaining wall has failed. Ask the engineer the reason and he will invariably tell you it was due to the porosity of the concrete. Frost and water have done their deadly work and in many cases new structures are necessary to replace the old.

Take the cost of the failure, the cost of repairs, or the cost of a new structure, and figure it out yourself. It would have cost a little more in the first place to have built the wall or structure of waterproofed materials which would have defied the ravages of frost, but once built they would have been as lasting as the Rock of Gibraltar. No repairs, no expenses, no dangers.

Waterproofed concrete cannot take up any appreciable amount of water, and consequently cannot freeze and expand with resultant disintegration, crumbling and cracking. Practically the only other cause for the disintegration of concrete, besides its permeability is inferior cement. The durability of concrete depends wholly on its density and hardness. Density is the word that every architect, engineer and cement user should have illuminated on an electric sign over his desk and underneath should be "colloidal waterproofer;" the greatest densifier in the world, because it is cement's assistant in the wonderful play called "perfect concrete," and the honors belong to the manufacturers whose days in the dark were spent in a vast amount of research work to invent the lacking material to be incorporated into the cement that would not weaken the tensile strength, retard or accelerate its action.

The colloidal waterproofer as described above has a past, present and future. I have successfully waterproofed many substructures where the water pressure was severe. The structures are bone dry to-day, and show no signs of deterioration as Mr. Gresser claims waterproofing materials will do. It is at present being successfully used all over the country by architects, engineers and cement users, who after careful investigation have recommended it for their waterproofing work. Its future cannot be anything but a success as the architectural and engineering profession is duty bound to specify materials of merit. Others will follow their footsteps, and by so doing will use a material that has made for itself a "universal success."

Decorating concrete has met with many failures which can be easily explained. Concrete surfaces exposed should not be decorated until the surfaces to be painted have aged six months. The concrete carries moisture up to that age; any paint applied to the exterior of a concrete surface before that time will be lifted from the surface by the moisture working its way to the moving air. The alkalies in the cement will destroy the vehicle and cause the paint to flake from the surface. To obtain perfect decorated concrete surfaces the following, if carefully followed, will give the results: First, see that the concrete is properly aged. Second, that the surfaces to be decorated are perfectly dry. Third, first apply a priming coat of a material of a cement body and a china-wood oil vehicle. The primer penetrates into the voids in the surface and fills all the fibrous channels which would otherwise allow the percolation of seepage water. After this priming coat has dried for forty-eight hours in good drying weather, second coat with a cement paint carrying the same vehicle. These materials can be obtained in open market in many different shades and are manufactured by leading waterproofing and damp-proof concerns that will stand back of their materials.

Cement floors, no matter how carefully prepared, will dust; oil and grease will penetrate the surface and cause the cement to disintegrate. The treatment of cement floors has passed the infancy stage. Thousands of cement floors have been made dustproof, oilproof and waterproof all over the country, and it is a recognized fact that cement filler and cement floor paint as manufactured by reliable concerns are staple. Their trial has ended, and for the benefit of those who are not familiar with these materials I will say that they have been successfully used in garages (where heavy automobiles with chains on the tires are constantly running over them), hospitals, hotels, power houses, office buildings, loft buildings, school houses, sugar refineries, printing establishments, and in hundreds of other types of buildings with an unbroken success. In the Woolworth Building, New York City, the tallest and largest office building in the world, the floors are painted. The World's tower building, the tallest loft building in the world, have the floors painted, the St. Lawrence Sugar Refineries, Montreal, have the floors painted and dustproofed. The Panama Canal Commission have used thousands of gallons. I illustrate the above structure so that my readers can verify my statements. My experience has been vast and practical; some of the largest and most difficult waterproofing operations have been successfully made watertight under my supervision, and by the methods above described. So you, my readers, are taking no chances by following my methods, and I can assure you that your troubles with waterproofing, decorating and dustproofing of concrete will be ended.

The Canadian pavilion to be erected at the Panama-Pacific International Exposition, to be held in San Francisco next year, will be the largest exhibition building ever erected by the Canadian Government. It will be 340 ft. long, 240 ft. wide and 50 ft. high, and the total expenditure upon building and contents will amount to about $600,000. Mr. George Freeman, a London architect, is designing the structure.

In places where public water supplies are available, little or no attention need be paid to the quality of the water for concrete, but in cases where water has to be drawn from streams or lakes careful examination should always be made. Manufacturing effluents, sewage, and slime are always prejudicial to concrete, and where poor results follow the blame is not infrequently laid on the cement instead of on the unsuitable character of the water.

An Analytical Study of Composition Flooring Material

By H. M. Hooker, Pittsburg

THESE notes are the issue of a two years' investigation of composition flooring involving a personal study of work and manufacturing methods in the United States, Germany, France, England, Belgium and Austria. They aim in some measure to serve two main purposes, to spread more accurate information as to composition flooring and its characteristics, and to provoke and stimulate a much more careful and scientific study of flooring problems.

For the last half century an improved flooring and surfacing material has been steadily sought in every civilized country. Many chemists and workers in Germany, in the United States and in other countries have seen bright prospects for progress in the use of magnesia cement products, and particularly in Germany have worked with varying success toward a more and more perfect flooring surface. The result is the so-called composition flooring that is rapidly extending in use to-day.

History

The history of this material, like that of many another, has been one of apparent early success, failure, disappointment, advance and ultimate commercial success. The basic process was worked out, or at least given to the world, in 1866, by Stanislaus Sorel of Paris, France, who then took out patents on a cementing material composed of magnesia and chloride of magnesium as the two chief ingredients to which other powdered substances could be added. Somewhat later "Sorel Stone" was widely hailed as a valuable addition to the building resources of our own and other countries. Experience and use, however, make it clear that the weathering and enduring properties necessary, particularly for exterior use, were missing and Sorel Stone failed of its early promise. It was not there with the staying qualities. But chemists, manufacturers and workers had been given a suggestion, a working basis for study, experiment and effort. From Sorel's basic compound they have developed a permanent floor surface by the addition and treatment of different ingredients. Some 120 different chemicals and some 88 formulas have been tried out commercially in this country alone. It is mainly due to the German chemists, however, that a really desirable commercial material has been evolved. Gradually, through improvement, failure and again improvement, the border between a doubtful and a really desirable flooring material was crossed. This occurred about seven years ago, and since that time most of the German manufacturers, and there are now 150 of them, some of the English and the American manufacturers have been furnishing a durable, desirable material.

General Description of Composition Flooring

Composition flooring is a light-weight, fireproof, resilient covering. It is laid plastic, usually about ½ in. thick, and sets in a few hours into a seamless, tough, warm and rather quiet mass; in appearance and feel not unlike high-grade battleship linoleum. Its jointless character and comparative freedom from cracks due to warping, uneven settlement and vibration of buildings give it special sanitary value. It is laid over wood, metal, or concrete, and adheres firmly thereto. It appears in many colors and combinations of color from black to a light pearl gray. Probably 98 per cent of the work, however, is red, buff, or gray. In general, colors other than these three are utilized for borders, ribbons and special designs only. Mineral pigments are used almost universally, and, except in the blues and greens, the colors are fast. Blues and greens in the course of years fade to much lighter shades than when first installed. This fading detracts somewhat from the appearance of the work, but does not accompany any appreciable deterioration in wear or life.

Field of Use and Usefulness

From the start magnesia cement flooring has attracted attention primarily because of its sanitary qualities. These it combines with a warmth, resilience and degree of quietness not possessed by concrete, tile or terrazzo. It was first installed in hospitals, schools, asylums, public and semi-public buildings. Its use in buildings of this character has extended more and more rapidly during the past few years so that there are to-day probably not less than 6,000 such installations in this country. It was then laid and tried out with a favor that has steadily gathered momentum in other places where cleanliness has been a chief desideratum. I refer to restaurants, dairies, candy factories, hotels and the service parts of residences.

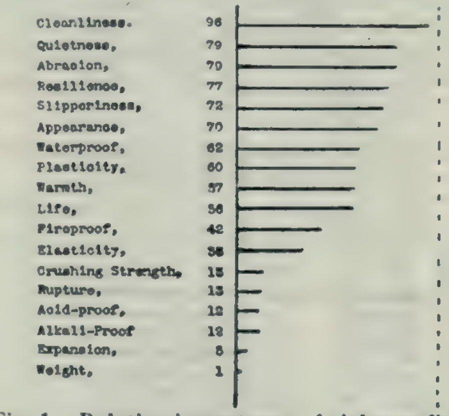


Fig. 1.—Relative importance of eighteen floor properties.

To enumerate all of the classes of buildings in which it has been used with some satisfaction would be to mention practically every type of fireproof building in existence. The following are, however, types in which it has to date demonstrated great usefulness: hospitals, schools, institutions, power plants, stores, dairies, restaurants, hotels, industrial plants, firehouses, garages and the service parts of residences.

It is extensively used for wainscot, base, both treads and risers of stairs, trim and even ceiling. It is as a flooring, however, that such a material is subjected to the severest use, and for this reason the discussion will be concentrated upon its floor value.

Manifestly the usefulness of any flooring material rests in its physical characteristics and properties. The engineer or architect who chooses wisely narrows his option to proved materials. He then applies common sense and makes a more or less thoughtful, considered selection of the material which will, according to the data available, best answer his purposes. If he has been even slightly thorough he has faced many factors, each of inconstant value, varying with the use to which the flooring is to be subjected, but each of which must none the less play its part more or less consciously in the final determination. What are the properties that he must weigh in an even semi-scientific appraisal? I find no less than 18 important factors. They are: 1—cleanliness—sanitary characteristics; 2—quietness; 3—immunity from abrasion; 4—resilience; 5—immunity from slipperiness; 6—appearance; 7—degree waterproof; 8—plasticity; 9—Warmth—thermal insulation; 10—life—immunity from deterioration with age; 11—degree acid-proof; 12—degree alkali-proof; 13—fire-resistance; 14—elasticity; 15—crushing strength; 16—structural strength; 17—immunity from expansion and contraction; 18—lightness.

Under some conditions appearance is of prime importance; under others, cleanliness; under others, freedom from abrasion. But for the great majority of flooring conditions the relative value of each factor corresponds to its place in the above list. A closer relative valuation is to be found in Table No. 1.

The above table represents a valuation placed upon each characteristic after weighing it under 14 standard conditions of use in restaurants, toilets, factories, hospitals, schools and residences. No doubt every thoughtful appraiser will use slightly different figures. The general results, I believe, closely approximate those here given.

Comparison of Composition Flooring with Other Standard Materials

In the discussion 19 flooring materials have been ranked in 18 different relations. But what, summing it all up, is the relative worth of each flooring material under conditions of normal usage? What value must we assign to each? Manifestly, the figure will vary with the use to which the floor is to be subjected, and any floor problem should be weighed with its special conditions in mind. Most floors will approximate one of the fourteen types already discussed. In that event if my appraisals are just, the computing of the value of each flooring material for the place is merely a matter of arithmetic. (See Table No. 2.) These data yield the following batting averages:

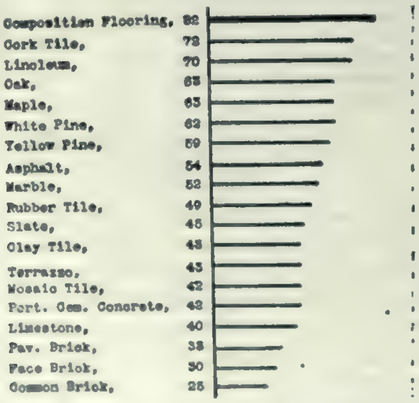


Fig. 2.—Relative values of nineteen flooring materials for average conditions regardless of cost.

At the first glance it may be somewhat startling to note that even regardless of cost composition flooring ranks above all competitors and some 9 per cent. above cork tile, its nearest rival. Were it a freak, or an old material adapted to a new use, this would be indeed surprising. But under the conditions of its birth and growth it is but natural. Composition flooring is the issue of prolonged scientific effort. The properties most to be desired in a flooring were repeatedly determined and checked by analysis, observation and experiment. A wide range of materials possessing these properties was assembled in different proportions. The synthetic building up of a composite material possessing a happy blend is the outcome. Composition is the result of a successful attempt to jump its competitors' liabilities while bringing their assets into chemical bond. It is not the product of one brain or of one year, but the issue of a number of years of effort on the part of several hundred chemists and several thousand workers under varied conditions in many countries.

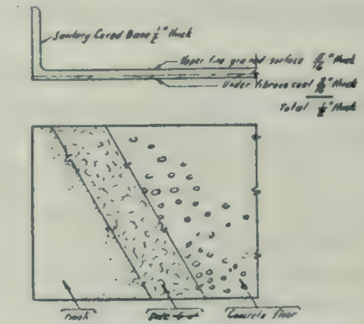


Fig. 3.—Typical composition flooring and base installation on concrete floor.

Conclusion: Composition flooring is the issue of scientific effort to incorporate in a flooring the physical characteristics most to be desired for any given conditions. It is already a valuable material. Like steel, concrete and artificial slate for many purposes, it is of greater value than any of its ingredients. How rapid its extension in use will be and what integral improvements the future has in store depend upon many factors. Practically everyone who has given it careful study is convinced that it will soon be generally recognized and extensively used as one of the valuable, standard building assets of this country and the world.

According to a statement made recently by Sir Donald Mann, the agreement between the Canadian Northern Railway and the city of Vancouver, in regard to the taking over of False Creek and developing it as the Pacific Coast terminus of the company, will be carried out as it stands. The company is not seeking any amendments to that agreement, and the bargain will be completed within the time stipulated, which is now only a little over four years. Sir Donald further stated that the company would enter the city over its own road, although no definite location of the route had yet been decided on.

The 1913 output of cement in the United States is estimated at 90,000,000 bbls. Some energetic statistician has stated that this would fill 529,000 freight cars of 30 tons capacity. These cars, consolidated in one train, would reach from Portland, Me., to San Francisco and from San Francisco to Los Angeles. If these 90,000,000 bbls. were all handled in sacks it would mean, of course, 360,000,000 sacks of 95 lbs. each. If these were set end to end they would go around the world about six times.

Types of Hollow Tile Fireproofing — Their Manufacture and Burning

INTERESTING observations on the above subject were contained in an informative paper read by Mr. Millard F. Gibson, Ceramic Engineer, National Fireproofing Company, at the annual convention of the Canadian National Clay Products Association on January 29. Having outlined the heads under which he proposed to discuss the subject, Mr. Gibson said:—

The manufacture of hollow tile fire-proofing becomes extremely intricate for the factory man because it is an operation that is almost impossible to standardize. The complexities will be readily appreciated when it is understood that a factory equipped to cater to the demands of the trade must manufacture from two hundred to three hundred different shapes and sizes ranging in dimensions from 1 in. x 12 in. to 16 in. x 12 in. and including lengths from 2 in. to 40 in. If the field of fire-proof house construction is entered an additional fifty to seventy-five shapes and sizes will be added, making a total of three hundred to four hundred and the total number of dies required from one hundred to one hundred and fifty.

There is seemingly no absolute limit to the demands imposed on the manufacturer, as the necessity for new shapes is continually arising owing to difficult and necessary steel framings, and the demands of architects and engineers for material for new uses to conform to certain required standards. In consequence it will be readily seen that the constant change in trade demands necessitates a constant making of new dies, and an adjusting of old ones and this lessens the possibility of systematizing the clay preparation, general shop practice and particularly the drying and burning treatment.

Type of Body Desired and Clay Preparation

These two operations—determination of type of body desired, and clay preparation—are dependent one upon the other, and in consequence it will be appropriate to consider them in conjunction with each other.

Hollow tile fire-proofing is specified as: 1, dense; 2, semi-porous; 3, full porous, and the fully equipped factory is capable of producing all three types. Dense hollow tile bodies are those in which the body is to all intents and purposes as nearly vitrified as possible. Semi-porous hollow tile bodies are those to which a proportion of some carbonaceous or bituminous substance has been added that will burn out during the firing treatment leaving minute open cells in the body. Full porous hollow tile bodies are those to which have been added a proportion of bituminous matter as large as the plasticity of the clay will allow. In many cases full porous bodies are specified 25 per cent. to 40 per cent. meaning that these percentages of the total volume of a cubic inch of the body shall be voids. The only method in vogue at the present time to produce such a ware is to introduce the required percentages by volume of the clay mixture of some carbonaceous matter that will burn out. The carbonaceous and bituminous anti-plastics usually added may be saw dust, manure, fine straw, coal slack, ground coke, etc.

In determining the type of burned body required consideration must be given to the uses to which the finished pieces will be put. It is necessary to determine: 1, what will be the crushing strength per sq. in. net area of the burned piece, net area meaning only the solid portions of the hollow tile, exclusive of the cells; 2, weight per cubic in. of the burned ware net; 3, ability of the ware to resist heat; 4, character of the body; 5, building code.

Five, Building Code, 2, weight per cubic in. of the burned ware net; 3, ability of the ware to resist heat; 4, character of the body.

The answer to above questions involves a statement as to what is the best, the most efficient, type of hollow tile fireproofing to use. As this is a much-mooted question it will be dealt with under

Characteristics of the Burned Ware

It will be seen how necessary it is to consider what sort of body is to be ultimately obtained as the addition of foreign anti-plastics mentioned, saw dust, straw, slack, etc., influences the clay mixture; the clay mixture influences the working properties and the working properties determine: 1, type of die to be used; 2, design and speed of machine used; 3, drying treatment; 4, burning treatment. Of the preparation of the clay not much can be definitely said as this will vary to a great extent in detail with locality. This much, however, can be said; whatever clay mixture is decided upon it must be kept homogeneous, particularly when making the larger sizes of ware. Only can liberties be taken in this respect with smaller sizes. Customary practice is followed in grinding the clays, pug mills, disintegrators, roll crushers being used as conditions demand. Tempering may be done in wet pans, pug mills, etc.

General Shop Practice

Hollow tile fireproofing may be made on: 1, sewer pipe presses; 2, horizontal steam plunger presses; 3, auger machines—either horizontal or vertical delivery.

This is quite a range of methods but I should say the majority of ware manufactured at present is made on horizontal auger machines.

A discussion of types of machines is to no purpose as no one machine can be expected to adapt itself to all clay conditions, and adjustments must be made to meet the demand of the locality.

Adjustments must be made to sewer pipe presses and horizontal steam plunger presses to produce the maximum amount of ware with the least expenditure of power. Proper ratios of diameters and lengths of steam cylinders to clay cylinders must be determined. Size of intake and exhaust ports on steam valve determine speed of press which in turn is determined by character of clay being worked. On auger machines the type of auger and propeller, the shape of the nozzle and then the kind of nozzle liners all depend on the character of the clay being worked, fineness of grain, plasticity, etc., although the straight barrel or nozzle machine is being used to-day more than any other type. The call of the auger machine is to produce the greatest amount of ware with the minimum wear and tear on the machine and the minimum consumption of power. Hollow tile imposes a greater load on a machine than brick, due to the cores obstructing the free issue.

Hollow tile fireproofing may be loaded on dryer cars, sewer pipe trucks, or any of the methods in vogue.

Hollow Ware Dies

The study of hollow ware dies presents the greatest field for investigation in the industry, on which much valuable information remains to be collected, and of which volumes might be written. The investment in dies in the well equipped hollow tile fireproofing factory is tremendous. Not only must the patterns, castings, machine work, be considered in determining the final cost of the die but also the labor utilized in adjusting it. Dies may be of cast iron, cast steel with bridges, of the same material or of machine steel. They may be high bridge long stem, or low bridge short stem. They may be thick bridged or thin bridged. They may be made with a short boss or a long boss, lined or unlined, lubricated or non-lubricated. The character of the clay and the shape of the piece to be manufactured determine the kind of die from which best results may be obtained in each locality. The friction on ware being forced from a die is essentially greatest on the shell of the piece while the pressure of the auger is greatest at the centre. The die must be either made or adjusted to equalize the rate of flow and the pressure at all points in the die. Drying and burning are the measures of correct die construction and adjustment.

Characteristics of the Burned Ware

The ware, having been burned and drawn from the kilns, in order to study its characteristics it will be well to consider these under the different types—dense, semi-porous and full porous. Dense body ware is as nearly vitrified as possible; of low absorption and in the great number of cases brittle. Of the three types of body this has the greatest conductivity. Hollow tile dense is usually of thin shells and thin webs. This type of ware furnishes the required strength with the least weight per cu. in. Its brittleness and high conductivity are its drawbacks. This type of ware is usually made from high-grade fire clays or clays that are capable of receiving severe burning treatment without presenting distortion of the piece.

Semi-porous ware has as a rule shells and webs of slightly increased thickness over dense ware. This increase accomplishes two purposes. 1. It admits of the introduction of non-plastics and still allows easy working of the mass. 2. It maintains the crushing strength per square inch. Foreign matter that burns out of clay bodies essentially leaves them weaker, and to preserve the strength of shell and web it is necessary to make them thicker. Semi-porous ware is less brittle than dense, and of lower conductivity. Its weight is slightly increased over that of dense ware, being of slightly greater absorption. It is easily laid, easily cut. The bulk of the fireproofing manufactured to-day is of the semi-porous type.

Full porous ware is as a rule from 5 per cent. to 12 per cent. heavier per piece than semi-porous. To maintain the strength of the piece the shells and webs are much thicker than semi-porous. Its conductivity is the least of any of the three types. It is a tough, sturdy type of ware with the greatest absorption of any of the three and superimposes a 5 per cent. to 12 per cent., average 7 per cent. greater wall or floor load per square foot than semi-porous. There is less of this type manufactured on this continent than either of the other two.

The physical relation of porosity and absorption in clay wares has been gone into rather thoroughly, and as determination of percentage of absorption is the first step in a porosity test it will be well to consider absorption and what it primarily determines, as porosity is a secondary determination.

The widely used absorption test consists in soaking the piece in water, weighing before and after, the gain in weight being calculated in the percentage of the dry weight. It has been shown by experiment that a piece of burned clay, after having been soaked six months will still be gaining slightly in weight, but that 90 per cent. of the final total will have been accomplished in forty-eight hours; and this length of time was once adopted by the N. B. M. A. as standard.

The length of soaking period and absorption depends on 1, pressure; 2, size of piece; 3, porosity. A given piece will have a greater gain if soaked in a receptacle under a vacuum pump than if soaked at atmospheric pressure, as the absence of air in the pores under the pump allows water to completely fill them.

Actual absorption is only used in determining or comparing failure as to strength and weather resisting qualities, and is primarily used to express quality, and secondarily is translated in terms of porosity.

Porosity is the volume of pore space between particles of clay, expressed in percentages of total volume of piece, and depends on the size and shape of the particles making up the mass.

$$\text{Por} = \frac{W-D}{W-S}\,100$$

W = wet weight.
D = dry weight W—S = Volume
S = suspended weight.

$$\text{Por} = \frac{L}{V}\,100$$

L = wt. water absorbed (gain in wt.)
V = volume of test piece.
From specific gravity

$$\text{Por} = \frac{\text{Real}-\text{App.}}{\text{Real}}\,100$$

This specific gravity may be determined by grinding piece to fine powder.

These formulae and standards must come from the laboratory and hardly fall within the work of the factory operator, yet a knowledge of them is a help. It is consequently seen that because a piece of fireproofing absorbs 10 per cent. of its weight of water it is not 10 per cent. porous.

Were it possible absolutely to vitrify to non-absorption the clay walls surrounding void spaces, then porous ware would resemble coral and not a sponge. But we have accepted vitrified ware with absorptions as great as 5 per cent. and 8 per cent., consequently moisture will continue to pass through the thin walls into the closed pores of the piece. Clay ware overburned to a vesicular, scoriaceous mass approaches nearest to the coral theory.

A word in conclusion as to the best type of fireproofing—dense, semi-porous or full porous. All will withstand as great or greater heats than the supporting steel; that is the major requirement. Consequently increased porosity would not seem to be a measure of better fireproofing.

I would now respectfully suggest that a committee be appointed to go into the subjects of:—standards applied to size of brick; crushing strength of brick walls; crushing strength of hollow tile, sewer pipe, etc., so that questions involving relative merit of clay products may be definitely and intelligently answered.

The city council of Regina, Sask., has approved the expenditure of $140,000 on sewerage extensions; $450,000 on pavement work, and $295,000 on street railway extensions.

According to a report from Saskatoon, Sask., an interview with leading local architects is productive of the information that most of them are engaged on plans of important buildings contemplated for spring commencement, but concerning which they are as yet somewhat reticent. They would at least admit however that prospects were quite satisfactory—indeed much more so than might have been expected or was generally realized. It is admitted further that some very important building developments involving Old Country capital will be announced shortly. The building supply business is also looking up, and enquiries are coming in most encouragingly. Building contractors anticipate a good year.

Progress at Vancouver and the Coast

Excellent Records on Larger Undertakings — The Hudson's Bay Company's Addition, Hotel Vancouver and Other Big Building Work

Correspondence of the Contract Record

Vancouver, Feb. 12th, 1914.

NOTWITHSTANDING the extremely unfavorable state of the weather at the Coast during the last few weeks noteworthy progress has been apparent on practically all of the large buildings under construction, in various parts of the city. Chief among the contracts on which activity has been most pronounced are the new C. P. R. Hotel Vancouver and the six-storey addition for the Hudsons' Bay Company, two immense projects possessing many outstanding features of constructional interest. In the case of the Hotel Vancouver, the steel frame work in the 11-storey portion of the Granville street wing adjoining Georgia street has been completed and the foundations for the remainder of this wing are in place and work well under way on the lower storeys. The central and main section of the building is gradually assuming a finished appearance with the exterior facing of brick and terra cotta practically in position to the full height of 16-storeys. The contractors have estimated that over 4,000 tins of steel will be used altogether in this contract. In the main entrance vestibule on Georgia street marble, mosaic and terrazzo tile will be used for the floor and ornamental plaster for the ceiling. The vestibule will contain 20 pillars, each of which is to be panelled in marble to a height of 4 feet and above that in Austrian oak. A similar style of wainscotting will be used for the entire ground floor. The building will contain 700 bedrooms altogether, each room having access to a private bathroom. All bedrooms will be fitted with solid oak doors and the interiors will be finished in white enamel. A convention hall measuring 50 x 100 feet will be one of the features of the Granville street wing. Provision has been made for a billiard room of similar dimensions directly underneath the convention hall in the basement. The hotel will have four main entrances altogether, one of these being in the Granville street wing and leading directly to the convention hall. A roof garden with pergola measuring 60 x 200 feet will comprise the entire 16th storey of the central building. There will be 18 electrically operated elevators in the hotel. In order to ensure the completion of the work by January, 1915, it is necessary to have over 400 men constantly employed. The cost of the entire contract is expected to run as high as $2,500,000. Mr. Francis S. Swales, architect for the C. P. R., prepared the plans, and Messrs. Skene & Christie, Vancouver, are carrying on the work of construction.

Hudsons' Bay Addition

Rapid constructional progress is in almost daily evidence at the corner of Georgia and Seymour streets, Vancouver, where Messrs. Rourke, McDonald & Moncrieff are erecting a massive reinforced concrete store addition for the Hudson's Bay Company. A start was made with the terra cotta facing at the end of January, and the efforts of the contractors are being directed towards completing this part of the work with every possible despatch. The building occupies a site measuring 146 x 175 feet, and with the foundations constructed about 50 feet below the surface and strong enough to support five additional storeys, this is unquestionably the most substantial example of reinforced concrete work in the city. There are 59 concrete vertical supporting columns altogether, each embedded in a concrete foundation which measures 8 feet square at the sub-basement floor. The columns themselves are 4 feet square and taper at the rate of two inches to each floor. The space below grade is occupied by the engine room, sub-basement and basement floors. Steel and concrete with terra cotta facing are being employed in the addition which forms only one-half of the entire contract, plans having been prepared for a duplicate building which will have frontage on Georgia and Granville streets. The street elevations of both structures will be decorated with rows of Corinthian columns. Messrs. Burke, Horwood & White, of Toronto, are the architects for the work, which, when fully completed, will represent an outlay exceeding $2,000,000.

Messrs. Snider & Brethour are making good progress with a five-storey building which they are erecting on Beatty street, near Robson street, Vancouver, for Cope & Son, electrical contractors. Reinforced concrete and brick will be employed in this structure, which measures 60 x 140 feet, and will cost approximately $70,000. The building will have a granite base with stucco finish for the upper portion, tar and gravel roof and galvanized iron cornice. The mechanical equipment will include two freight elevators, and a complete system of hot water heating.

Hudson's Bay Company's new store addition at the corner of Georgia and Seymour Streets, Vancouver.

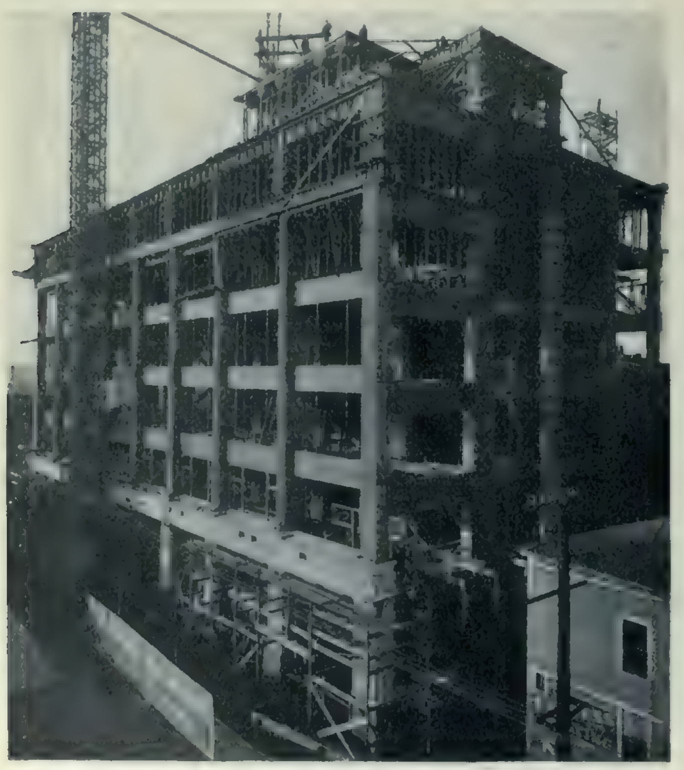
An immediate start is planned in connection with the construction of the new immigration building in Vancouver for which the contract was recently awarded by the Dominion Department of Public Works to Messrs. Snider & Brethour, a local firm of contractors. The building is to be erected on a site measuring 211 x 61 feet opposite the C. P. R. docks, and will be of steel construction, with brick walls and concrete floors. Concrete piles will be driven in order to support the foundations of the structure which will abut over the water. The figure of the successful tenderers was $277,449, this amount being the lowest of a large number of bids submitted.

Excavating operations are proceding on the site of the Vancouver-Prince Rupert Meat Company's new reinforced concrete warehouse on Water street, Vancouver, and preparations are being made by Mr. E. J. Ryan, who has the general contract, for constructing the foundations of the structure. It is expected that the work will involve an outlay of at least $40,000. Detail plans of the building were prepared by the company's draughting department.

Construction work will probably be started this spring on a six-storey warehouse which the McClary Manufacturing Company is planning to erect on a site measuring 120 x 125 feet at the corner of Smythe and Homer streets, Vancouver. It is believed that a structure of the reinforced concrete type will be decided upon, with trackage facilities and loading platform at the rear.

Work is about to commence on the proposed new factory building for the Restmore Manufacturing Company, which is to be erected on Venables street at the head of False Creek, Vancouver. The building is to be of brick and mill construction costing approximately $147,000. Mr. A. Moir has charge of the general contract.

It is reported in Vancouver that the Imperial Oil Company is contemplating the immediate erection of a large warehouse and office building at Prince Rupert, which is to be utilized as the company's supply depot for the Northern B. C. trade. The estimated cost of the building together with five oil tanks, is placed at approximately $200,000. The site selected is on Hay's Creek Bay.



Another view of the Hudson's Bay Company's addition at Vancouver.

Plans are in course of preparation by the construction department of the Vancouver School Board for an 8-room reinforced concrete school building to be erected on the corner of 20th avenue and Clinton street, at a cost of $50,000. In addition to this building the school board will ask the city council for funds for an 8-room reinforced concrete building on Pender street, to cost about $50,000; a 12-room reinforced concrete building to be erected, most likely on the Strathcona school site, to cost about $75,000, and for a reinforced concrete gymnasium building to be erected adjoining the King Edward High School, the cost of which is to be about $50,000. Under the heading of repairs and improvements the board asks for $80,000, including $15,000 for changes to the school heating plants. The list of new work will also include funds to improve the grounds at the King Edward and Britannia high schools.

Recent amendments to the Victoria building by-law provide for an increase in the height limit of reinforced concrete structures to 130 feet, this being also the limit allowed for steel frame buildings erected in that city. For any other type of structure the limit in height is retained at 80 feet, but further restrictions are made to the effect that no building shall exceed in height the following times its least dimensions at the base; for buildings with skeleton frames, four times; for buildings with masonry walls, three times; for frame buildings, one and one-half times. These restrictions also apply to wings for existing structures. The height of all wooden or frame buildings to be used for human habitation will in future be limited to 40 feet, thus permitting only three storeys in structures of this type. Another important amendment and one which had become imperative, was that of raising the area for a building containing a single room. The old by-law restricted the area to 7,000 feet, but this has been materially increased, and will apply to department stores, churches, theatres, drill halls, skating rinks, public halls, places of public assembly and sawmills.

Tenders closed at Ottawa on February 16th for a new addition to the Victoria Post Office on which the sum of $150,000 is to be expended by the Dominion government. On the rear section of the present structure are to be added two storeys. This will bring the entire block to a uniform level in respect to height, making a large, evenly proportioned building, with expensive frontages on Government, Courtenay and Wharf streets. The proposed alteration is expected to give enough additional space to provide for present requirements, as well as those of several years to come. The entire ground floor, from Government to Wharf streets, is to be given over to the post office proper. The second floor will be used by the customs department and is to be laid out with every convenience and in thoroughly modern fashion. The floor above is to be occupied by offices which will be used as extensions for the various departments in urgent need of larger quarters. The contract for the proposed addition will be awarded without delay, and it is planned to have the work carried out as expeditiously as possible.

Plans are in course of preparation for a new hotel building to be erected at Port Alberni, on the west coast of Vancouver Island. According to the meagre details available, the structure will be of brick and mill construction, three storeys in height, and will contain 70 bedrooms. It is understood that Vancouver capitalists are behind the enterprise.

Messrs. Knott & Jones, a Victoria contracting firm, have been awarded the general contract for the Dominion Government public building at Port Alberni, the cost of which will be about $30,000. This building will have a heavy concrete foundation with brick for the exterior facing, and stone trimmings.

Application was made to the provincial government recently by an English syndicate for the lease of several small islands in the North Arm of the Fraser River, on which it is proposed to establish a shipbuilding plant and yards. Preliminary plans in connection with the project are being prepared by Mr. N. A. Leech, Vancouver, and it has been announced that an expenditure of $100,000 is contemplated in the near future.

According to a recent announcement work will commence shortly on a brick manufacturing plant at Port Haney, Fraser Valley, B.C. Mr. W. J. Graham, who is a large property owner in the district, is behind the project, and states that a plant will be erected which will have a capacity of

500,000 bricks during the first year of its operation. No further details are available at the present time.

Municipal Developments at Saanich and Point Grey

The municipality of Saanich, adjoining the city of Victoria, is to be congratulated on its choice of Mr. David W. Johnson to fill the position of municipal engineer shortly to be vacated by Mr. C. H. Topp. Mr. Johnson has been chief engineer in the municipality of Point Grey for the last five years, and during this period has rendered noteworthy service in transforming the district from a rural suburb to its present standing as the most progressive municipality, from an engineering standpoint, on the mainland of the province. In his new sphere of activity he will be called upon to handle municipal development work of a nature similar in many respects to the undertakings which he has dealt with so successfully in Point Grey. Previous to his connection with the engineering department of Point Grey Mr. Johnson had been engaged in a civic office in the town of Ayr, Scotland. A recent report submitted to the Point Grey council by Mr. Johnson give the following summary of works carried out by his department during 1913:

Sewers, 12.16 miles; sewer connections, 4.3 miles; roads paved, 2.47 miles; roads macadamized, 6.14 miles; cement walks, 0.42 miles; cement curbs and gutters, 0.38 miles; roads graded, 2.24 miles; roads cleared, 3.30 miles; lanes, 2.70 miles; roads planked, 1.47 miles; and wooden sidewalks laid, 17.19 miles.

The total expenditure on works carried out during the year amounted to $608,726, being divided as follows: Roadways, $141,734; sidewalks, wooden, $17,241; lanes, $7,852; sewers, $421,109; local improvements, $3,133; parks, $1,953; box drains, $682; gas plant buildings, $1,133; and engineering, $13,905.

With regard to the sewer works, the report states that it is worthy of mention that the rates per lineal foot for the various sewers laid last year, with the exception of the outfalls, were approximately 15 per cent. less than the rates for similar work carried out in 1912.

During the year, the report continues, plans showing 25 miles of street grades had been established, and plans showing 43 miles of porposed grades are now practically completed. The engineer remarked that this policy, besides anticipating the field data for future permanent road improvements, which when decided upon can be carried out immediately, eliminates the delay of building operations, and also admits of sewer and water main extensions and other underground works being installed permanently, thereby obviating the possibility of having to lift and relay these when permanent grades are established.

In a table with regard to general improvements it is shown that there are 125.31 miles of travelled roads in the municipality at the present time 61.10 miles of which are paved or macadamized. Lanes cleared are 41 miles; roads cleared are 51 miles; roads contour graded 33.9 miles; roads permanently grades, 30.31; roads macadamized, 45.04 miles; roads paved, 16.06 miles; cement sidewalks, 28.06 miles, of which 27 miles are in Shaughnessy Heights, wooden sidewalks, 74.35 miles; storm water drains, 10.55 miles, and sewers, 49.70 miles.

Road Congress for Montreal

Further particulars of the first Canadian and International Good Roads Congress, to be held in Montreal from May 18th to 23rd, are now available. The congress will be held under the auspices of the Canadian Highway Association and Canadian Automobile Federation, with the co-operation of the American Highway Association. The principal object is to inaugurate a co-operative educational campaign which shall make for a uniform system of road building, proper methods, and economical management with a view to more practical work being accomplished. The promoters are of opinion that by an exchange of knowledge and experience by representative men much good can be accomplished. Amongst the proposed subjects to be discussed are matters relating to good roads legislation, the administration of public roads, the problems of construction and maintenance, the advancement of road building engineering in educational institutions, and other subjects of practical assistance to the good roads movement.

The various provincial governments have promised to send representatives, and invitations are also to be sent out to town engineers, county councils, boards of trade, engineering societies, and manufacturers' associations. A proposal will be put before the congress to organize an association with the object of developing the business interests of its members, and also with a view to giving assistance to municipal and other bodies desiring information as to road work. A feature of the congress will be an exhibition of various appliances used in the construction and maintenance of roads.

The official opening of the King Edward Highway, 45 miles in length, and connecting Montreal with the New York State roads, will take place during the week of the congress.

The Transportation Problem at Montreal

Mr. G. Janin, chief engineer, and Mr. McLeod, railway engineers of the City of Montreal, have submitted to the Controllers a report on the transportation problems of the city. A short time ago the Montreal Tramways Company and the Canadian Autobus Company presented rival schemes for subways and autobuses, to the Council, and these were referred to the city engineering department. The report is a very exhaustive one, and points out that traffic conditions have now reached such a stage that the providing of additional car tracks, the changing of routes, and increasing the number of cars will only secure temporary relief for a few months or a year or two, when the city will again be confronted with the problem of improving the service. The report, therefore, includes a series of recommendations for the construction of underground rapid transit lines, to be operated in conjunction with surface cars, and the combination of these two to be supplemented by such motorbus service as may be deemed necessary; the widening of two or three streets to be used as business boulevards and afford new arteries both for local car traffic and the increasing volume of vehicular traffic.

Owing to the extension of the city and suburbs, the rate of travel since 1899 has increased 310 per cent, or more than twice the rate of increase in population. The result is that there is an almost unbearable congestion of cars at the rush hours. The engineers discuss in detail various routes for subways, and recommend a subway running east and west from Frontenac street to Atwater avenue, via Ontario, Burnside and Luke streets, a distance of 3.45 miles, at an approximate cost of $8,800,000, a subway from Burnside street to Viger Square, via Craig and Latour streets, Dominion Square, and Peel street, 1.63 miles, approximate cost $4,800,000, to serve the down-town district; and a subway under St. Lawrence Boulevard, north and south, 3.45 miles, approximate cost $7,000,000. The total mileage is 8.21, and the estimated cost $20,000,000, exclusive of widening or extending streets and equipment and plant.

The engineers suggest that tunnels be constructed under the Lachine Canal, and also that considerable changes in the routing of the existing surface lines will be necessary, in addition to the construction of new surface lines especially in the outer wards of the city.

Personal Mention

Mr. E. H. Verner has been appointed engineer of the municipality of Port Coquitlam, B.C.

Mr. E. R. Bingham has been appointed City Surveyor of Port Arthur, succeeding Mr. A. L. Russell, who has resigned.

Mr. C. H. Topp, formerly City Engineer of Victoria, B.C., has been appointed Engineer of the Municipality of Esquimalt, B.C.

Mr. J. Anderson formerly City Engineer of Moose Jaw, has resigned his position as Superintendent of the Brandon Street Railway Company.

Mr. V. J. Elmont, A. M. Can. Soc. C. E., consulting engineer, Montreal, was among those who attended the recent convention of the American Concrete Institute and the Cement Show at Chicago.

Mr. H. T. Fisher, tunnel engineer of the Mount Royal Tunnel of the Canadian Northern, gave an illustrated lecture in Montreal on February 13, describing the methods of locating the line and of construction.

Mr. J. V. Nimmo delivered a lantern address on the construction of the C. N. R. lines between the Yellowhead Pass and Vancouver before the Vancouver Branch of the Canadian Society of Civil Engineers on February 3.

Mr. J. Mackenzie, Bridge Engineer of the South African Railway, has received from the Institution of Civil Engineers a Telford gold medal for his paper on "Strengthening of Wrought Iron Bridges on the Cape Government Railways."

Mr. E. Lepage, Sr., at one time a very prominent contractor, died in Montreal on February 13, aged 83. He built a portion of the Intercolonial Railway, and also many churches, colleges and public buildings. Mr. Lepage was a native of Rimouski, P.Q.

Mr. N. B. MacRostie, Assistant Engineer, Roadways Department, City of Ottawa, was a recent visitor at the office of the Contract Record. Mr. MacRostie has our congratulations upon passing the Final Examination of the Association of Ontario Land Surveyors.

Mr. A. J. McPherson has been appointed Chairman of the Government Finance Commission of Saskatchewan. He is succeeded in the chairmanship to the Highway Commission of that province by Mr. F. J. Robinson of Regina, formerly Deputy Minister of Public Works. Mr. McPherson is a graduate of the School of Practical Science, Toronto.

Dr. Horace L. Brittain, a native of New Brunswick, and a graduate of the University of New Brunswick, has been appointed Managing Director of the Toronto Bureau of Municipal Research, now being organized to carry out the suggestions and reforms contained in the Civic Survey Report, which is about to be issued in its complete form.

Dr. L. A. Herdt, of Montreal, Mr. O. Higman and Mr. A. B. Lambe, of Ottawa, and Prof. L. W. Gill, of Kingston, have been appointed honorary members of the International Committee which has been formed to organize an International Electrical Congress to be held in September, 1915, at San Francisco during the Panama-Pacific Exhibition.

Mr. Hunter McDonald is the new president of the American Society of Civil Engineers. Born in Virginia in 1860 and educated in Louisville, Ky., schools and Washington and Lee universities, Mr. McDonald entered the service of the Nashville, Chattanooga and St. Louis Railway as assistant engineer, in 1879, succeeding the late Col. R. C. Morris as chief engineer in 1892.

Mr. W. E. Woodhouse, who far the last four years has been assistant superintendent of motive power of the western lines, is appointed superintendent of the same department for the eastern division of the Canadian Pacific Railway, with headquarters in Montreal. Mr. Woodhouse has been in the company's employ for 22 years, the greater portion of which has been spent in British Columbia and Winnipeg.

Mr. Geo. T. Clark, formerly city engineer of Saskatoon, has been appointed vice-president and construction manager of Western Pavers, Limited, Winnipeg. Mr. Chas. Curtis remains president and sales manager of this company, with Mr. Henry J. Keith, formerly of Toronto, secretary-treasurer. It is of interest to note that since 1910 Messrs. Western Pavers, Limited, have built over one million dollars' worth of walks and curbs in the prairie provinces.

Mr. Edward Hervey Lee, who has been elected president of the Western Society of Engineers for 1914, has been chief engineer of the Chicago & Western Indiana Railroad and of the Belt Railway, Chicago, since 1898. Beginning railroad work as rodman for the Scotia Valley Railroad in 1880. Mr. Lee has given his services to railway engineering for practically 30 years. He was born at Dayton, Ohio, in 1863 and educated at Ohio and Wooster universities.

Mr. John Coates, founder and chairman of the engineering firm of John Coates, Limited, London, Eng., died recently. He was born at Newcastle-on-Tyne in 1846, and obtained his early engineering training at the Elswick Works. Having gained some London experience he ultimately established the business with which his name has been so prominently identified for many years. He had a branch office at Ottawa where he resided for sixteen years, and was associated with the installation of many important public works throughout Canada. For some time he was president of the Ottawa Gas Company, and the Ottawa board of trade.

Canadian President of American Road Builders' Association

Mr. W. A. McLean, Chief Engineer of the Highways Department of Ontario, who was elected President of the American Road Builders' Association at a meeting of that body held last week at the Hotel Astor in New York, enjoys the distinction of being the first Canadian to occupy that important office. Mr. McLean is well-known to readers of this journal by virtue of many able contributions published herein and any extended mention of him would be superflous. Most of us remember his succeeding "Good Roads" Campbell some

Mr. W. A. McLean, Toronto, the new President of the American Road Builders' Association.

years ago and everybody appreciates his zealous devotion to the interest of highway improvement—devotion which has contributed greatly to the fame of Ontario as an enlightened state which puts transportation facilities in the front rank of the things that make for a country's progress. Mr. McLean is a man of widely diversified professional experience and has attended all the more important road gatherings in Canada and the United States during recent years. He came into additional prominence last summer at the Third International Road Congress in London, Eng., a noteworthy event (reported in detail for this journal by one of its editors) attended by the representatives of some forty nations and states.

An Important Appointment

Mr. W. Furniss Clarke, who has been appointed General Superintendent of the large new Armstrong-Whitworth Steel Works, Longueuil, on the south short of the St. Lawrence, opposite Montreal, is an Englishman who has made good in Canada.. He has been connected with George Anderson & Company, Limited, for a number of years, and by dint of earnest work and ability has raised what was a branch office to the dignity of a Canadian Company, of which he was made managing director, with full charge of the company's business in Canada. Mr. Clarke is very well known amongst cut stone contractors from the Atlantic to the Pacific, and is held in high esteem by those with whom he has had business connections.

Mr. W. Furniss Clarke, General Superintendent, Armstrong, Whitworth Steel Works, Longueuil, Que.

On coming to Canada he started in an unimportant position with the Northern Electric Company eighteen years ago. He left that company after three years as chief draftsman, on being appointed, under the late David A. Murphy, as an assistant mechanical engineer with the Dominion Bridge Company, for whom he worked for several years.

Subsequently, Mr. Clarke was shop engineer of the Locomotive and Machine Company, Montreal, and of the Dominion Car and Foundry Company's Blue Bonnets Shops. Being at that time in very poor health, he decided to get out of the shops, and to take up the sales end with George Anderson & Company, the result being the building up of a large business for that company.

Instead of building stone cutting machines, Mr. Clarke will make the steel and tools, and is already enthusiastic as to the qualities of Armstrong-Whitworth steel for some planer tools.

He is most emphatic in his views as regards his Canadian citizenship and belief in the great future that lies ahead of his adopted country.

Canadian Railroad Development

The Canadian Pacific Railway is building a pipe line from Port Coquitlam to Port Moody, B.C., and at the latter place are to construct a large storage oil tank and pumping station. The company will also erect a wharf to accommodate the oil ships.

The Canadian Northern Railway Company has appointed Mr. A. R. Mackenzie, C.E., to examine the plans of the sewerage commission for work at the head of False Creek, and to ascertain an equitable basis on which to assess the railway company for the Clark Drive sewer.

Returns presented to the Dominion Parliament on February 10 give details of the new scheme of railway terminals at Quebec. The estimated cost of the original plans was $6,406,153, but the new scheme has brought the estimate down to $5,847,250, and besides, several modifications appear in the constructional plans.

Dr. John Humphrey Evans, who died at Barry's Bay, Ont., on February 11, following a fit of apoplexy, had been intimately associated with the building of the Grand Trunk line from Toronto to Burk's Falls in 1885, having been attached to the medical staff of the railway during the construction. He was a graduate of Trinity College, Toronto, graduating in medicine in July, 1885.

The Temiskaming & Northern Ontario Railway Commission have planned an inspection of the road in the near future for the purpose of deciding on improvements to be carried out during the year. The extension of the railway from Elk Lake to Gowganda is a matter for the government to decide as the country is almost exclusively mining, and railroad construction in that region will be difficult. About $50,000 has been expended in surveys as far as Sudbury, which will be the terminus of the branch. This will give connection with the Canadian Pacific and the Canadian Northern Railways.

An announcement is made that Mr. E. J. Mackenzie, son of Sir William Mackenzie, who returned to Winnipeg recently after an absence of two years in California, will assume active control of the Canadian Northern lines west of Lake Superior to the Pacific Coast, in the capacity of second vice-president. Mr. Mackenzie will be in complete control of the Transcontinental lines to be opened this summer. It is understood that Mr. A. E. Warren, present assistant general manager in Winnipeg will move to the Pacific Coast to take up the management of the Canadian Northern mountain division, and the office vacated by him will be filled by Mr. J. S. Cameron, general superintendent, Winnipeg.

The Toronto Branch of the Canadian Society of Civil Engineers inaugurated a series of monthly luncheons on February 11. The function was presided over by Mr. C. H. Mitchell in the absence of the Chairman of the Branch, Mr. A. F. Stewart. The speakers included Dr. Galbraith, Mr. C. R. Young and Mr. J. M. Clark, K.C.

Messrs. Wilson, Townsend & Saunders, engineers and contractors, whose headquarters are at Moose Jaw, Sask., have opened a branch office at 79 Spadina Avenue, Toronto. They have secured from the city of Toronto a contract for the construction of an underground sewage pumping station on Scott street, and they are looking forward to an active season in the east.

President—Mr. J. L. Skene, of Messrs. Skene & Christie, contractors.

Second Vice-President—Mr. T. J. Madlen, Manager Dominion Construction Company.

First Vice-President—Mr. W. M. Horie, of Messrs. Baynes & Horie, contractors.

NEWLY-ELECTED OFFICERS OF THE VANCOUVER BUILDERS' EXCHANGE

Vancouver Builders' Exchange an Active Body

GRATIFYING evidences of the success which has attended the organization of the building interests of Vancouver were forthcoming at the annual banquet of the Vancouver Builders' Exchange, reported briefly in our last issue. In our previous article we gave an outline of the addresses, together with a list of the new officers. We now have pleasure in presenting to our readers Messrs. Skene, Horie and Madlen, president, first vice-president and second vice-president respectively, and in giving supplementary particulars concerning the work and aims of the association.

Acting on instructions from the general contractors' section, the Secretary, Mr. W. Hamilton-Lindsay, has taken up with the Ministers of Public Works at both Ottawa and Victoria the question of having all plans for public work in British Columbia sent to the Exchange, with the result that the Minister at Ottawa has given instructions to that effect, though the Minister at Victoria states that they cannot depart from their regular custom of sending them only to Government offices.

The question of a uniform contract for general contractors, and also for sub-contractors has been the subject of several meetings between a committee of the Vancouver Branch of the B. C. Society of Architects and a committee from the general contractors' section, and between the general contractors' committee and committee from the sub-contractors, and is still under consideration. Some of the work which it is hoped the exchange will undertake at an early date has been mapped out as follows:

Employers' Liability Insurance: classified vs. flat rates.

A standard form of measurement.

Joint conferences between representatives of the organization and the city authorities with a view to securing a revision of the building by-laws.

The question of examining and licensing building inspectors, superintendents of buildings and clerks of works.

The Secretary's report also dealt with a number of innovations which it is proposed to establish at an early date, among these being a daily change hour for trading and business purposes generally, to keep constant watch over legislation and all other matters affecting the building industry in the interests of the members, to secure plans for public and other works upon which the members will be given an opportunity to submit tenders, to have a permanent exhibit of building supplies, to obtain the services of a competent lawyer, and to display daily bulletins of building information.

The Treasurer's report which followed indicated the excellent financial standing of the exchange, there being practically no liability.

Competitive plans have been received for the new Masonic Temple to be erected on the west side of Spadina Road, north of Bloor Street, Toronto. The first prize of $1,000 for the best plan is awarded to Mr. H. P. Knowles. A native of Hamilton, Ont., Mr. Knowles has been practising his profession as architect in New York for some years. Mr. John M. Lyle, the well-known Toronto architect, secured second prize, the third and fourth prizes being won by Messrs. Hutchison, Wood & Miller, of Montreal, and Messrs. A. W. Gould and A. E. Harvey, of Victoria, B.C., respectively. The building will cost about $300,000 and tenders will be called at an early date.

The profits of the Nova Scotia Steel and Iron Company for last year were $1,255,953, the largest in the history of the company, and an increase of $255,344 over 1912. After meeting all charges, writing off and appropriating sums to depreciation, reserve, etc., and paying a dividend of 6 per cent. on the common stock, $75,286 is carried forward. Mr. T. Cantley, the general manager, states that the demand for the company's products during the early months of the year were good. During this period a large tonnage was booked at fair prices sufficient to keep the mills fully employed until the closing weeks of the year, the result being that the outputs of iron ore, pig iron, steel ignots, billets, bars and forgings all showed substantial increases over previous years.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

At a cost of $150,000 the city of London, Ont., is to have a system of storm water sewers, and tenders for the work will be called in March.

Tenders are to be called for the building of a new $400,000 college in Montreal. The architects are Messrs. Peden & McLaren, Montreal.

Plans for a new horticultural building for the Central Canada Exhibition Association, at an estimated cost of $48,000, have been prepared by Mr. Allan Keefer.

The government has decided to grant in instalments a loan of fifteen million dollars to the Montreal Harbor Board, and two million dollars for this year's harbor works at Quebec.

The city of Toronto contemplates laying a new supply main in the north end of the city, at a cost of $525,000, also an extension of the high-pressure fire zone to involve an outlay of $500,000.

The Canadian Stewart Company has been given the contract for the new development works at Toronto Harbour, the contract price being $5,371,372. Between the highest and the lowest tenders there was a difference of $2,000,000.

The New Brunswick Wire Fence Company anticipate a good year's business judging by the number of orders at present on hand . The factory is equipped with up-to-date machinery for the production of woven wire fence and staples.

Messrs. J. A. Eaton & Son intend erecting a new factory at Orillia this year at a cost of $400,000. The plans have already been prepared and all that remains to be done is to receive the sanction of the ratepayers to a loan and a suitable site.

The city engineer of Maissoneuve, P.Q., has been instructed to prepare plans and estimates of a municipal housing system. The Mayor stated there was a shortage of 3,000 flats—a condition which will be accentuated when the Vickers, Limited, shipbuilding yard is completed.

Much satisfaction is felt in Fredericton, N.B., at the announcement of Hon. H. F. McLeod, M.P., that the St. John Valley Railway Machine Shops are to be located in that centre. The Federal Department of Public Works is also arranging for two new concrete wharfs to be built on the water-front in Fredericton.

Estimates for Toronto public works include $351,000 for the Sherbourne street bridge; $310,000 for the new bridge over the north ravine, Glen road; $335,000 for the Moore Park bridge connecting eastern and western sections of St. Clair Avenue. New tenders have been called for the new Gerrard street bridge at an estimated cost of $382,000.

Two 24-ft. hydraulic dredges with hulls 17 ft. long, 42 ft. wide and 12 ft. deep, to cost $500,000, have been ordered for the work of deepening the Toronto harbour. Each will have a capacity of 18,000 cubic yards per day. The contract for the two dredge hulls has been placed by the Canadian Stewart Company with the Polson Iron Works and Shipbuilding Company.

The Toronto Eastern Railway directors are to be consulted as to the possibility of the electric roads joining in the construction of a high-level bridge to cost $150,000, which would provide a level roadway across the West Don, Toronto to the centre of the city. An interim report has been laid before the township council of York by Mr. Frank Barber, township engineer.

The Ford Motor Company are about to erect a reinforced concrete building at the corner of Dupont and Christie streets, Toronto. The structure will be of five-storeys with basement, the front of the first storey to be used as a showroom and for offices, the front of the second storey being reserved for a stock room. The new building will be ready for occupation early next fall.

Plans have been prepared for the building of the new Knox Church at Stratford, which promises to be one of the most stately edifices in Western Ontario. The building will be of red brick with cement footings, and will have a tower, 24 ft. square, standing 84 feet from the ground. Tenders for the work are to be sent to the architects, Messrs. Lindsay & Brydon, Toronto, by February 27.

The Hepworth Silica Pressed Brick Company, at a meeting in Owen Sound, decided to purchase the machinery for their new plant and to complete the necessary buildings and equipment as soon as weather conditions permit. The new plant promises to be one of the most modern and complete in the province, having a twenty-four hour capacity of 88,000 bricks. The plant will be located near Hepworth.

The Chatham Builders' Exchange held their annual banquet on February 13 under most successful auspices. The question of appointing a building inspector for the city was under discussion and hearty agreement was expressed with the proposal. Mr. A. J. Dunn, ex-mayor, stated that last year Chatham had had one of the greatest building years in its history, and Mr. John McCorbia, mayor of the city, expressed the hope that 1914 would prove a banner one in the history of the Builders' Exchange.

The building programme for Montreal this year promises to surpass that of any previous year. Excavation is expected shortly to begin for the station and terminal buildings of the Canadian Northern Railway at the city end of the Mount Royal tunnel, and the erection of a temporary depot for passengers. Residential construction will be carried out on an extensive scale, and new factory buildings and extensions, public schools, fire and police stations are also included in the building programme outlined for 1914.

St. John, N.B., is entering upon a particularly heavy season of construction work. Details of the operations now in progress have been given in recent issues of this journal, but in considering these it is well to remember that there are the additional items included in the estimates brought down at Ottawa. These comprise: harbour and improvements, $3,000,000; new post office, $325,000; spur lines to Courtenay Bay, $134,000; extension of breakwater, $100,000; Partridge Island wharf, $50,000; quarantine station, $45,000, and other items, $66,000.

Discussing the possibilities of the different Canadian Provinces, experts of the Mines Branch, Department of Mines, Ottawa (who compiled a report recently declaring that Canada possesses gas and oil fields of considerable value which, if developed, may rival those of the United States) say that in Alberta deposits are considerable, but cost of drilling is high. The province of Quebec gives no indication at the present time of developing fields of either petroleum or natural gas. New Brunswick oil fields, however, show considerable promise, and of Ontario the statement is made that the production both of petroleum and natural gas is on the decline and the total depletion of the underground supply is approaching.

From a report issued recently by the Department of Mines, Ottawa, we learn that the production of clay products, lime, cement, stone and similar construction materials in Canada during 1912, reached a total value of $28,794,869, which represents an increase of $6,850,258 or 26.8 per cent. over 1911, in which year the production was valued at $22,709,612. The total production in 1910 was valued at $19,627,592, and in 1910 at $16,553,349. A satisfactory feature of the statistics for the past year is the fact that the Canadian consumption of products of this class is apparently increasing at a more rapid rate than production, which goes to show that construction materials are much in demand, and that the field of production is not by any means overcrowded.

About 150 members of the Engineers' Department of the C. P. R. attended the third annual banquet held at the Place Viger Hotel, Montreal, on February 14. Mr. H. Irvin, consulting right-of-way and lease agent, presided, and engineers from all parts of the system were present. The chairman referred to the immense growth of the C. P. R. and the engineering difficulties which had been surmounted. There were, he said, still great things to be done, and he was convinced that the difficulties which they presented would also be overcome. Mr. P. Motley referred to the building and double-tracking of the St. Lawrence bridge, and incidentally mentioned that the company had made an outlay of $75,000,000 on the east and west lines in the course of one year.

WESTERN CANADA

A new post office is to be erected at Calgary, Alta., at a cost of $250,000.

Medicine Hat, Alta., is to have new sidewalks at a cost of $115,000, of which $80,000 will be expended on concrete and $35,000 on curb and gutter.

Tenders have been called for a new water system at Canora, Sask. The source of supply is Crystal Lake, a distance of 14½ miles. The outlay will be about $200,000.

Edmonton public works this year include the laying of pavement involving an expenditure of $900,000; $227,000 on concrete walks, and $156,173 on the telephone system.

Regina, Sask., has decided on a waterworks system which will mean an outlay of about $290,000. The work is in charge of Mr. J. M. Mackay, Superintendent, waterworks department.

A movement is on foot to have the Saskatchewan government, Regina city council, Regina board of trade, Moose Jaw city council, and Moose Jaw board of trade co-operate with a view to improving the highway between these two cities.

A movement for the construction of better roads is at present engaging the attention of the Calgary board of trade. Recently a committee of this board waited upon the Hon. Charles Stuart, Minister of Public Works for the Province, to ascertain the government's intentions in this respect.

Mr. C. A. Dunning, member of the Saskatchewan commission which recently toured Europe, investigating grain conditions, has now advocated the construction of an inland waterway, permitting ocean-going vessels to travel to the prairie. The cost of such an undertaking would be enormous, but Mr. Dunning claims it is essential to make grain production more profitable in Canada.

A 5,000,000-gallon water storage basin costing $140,000 will be built within Regina's city limits during 1914. Supplemented by two new pumps which are to be purchased, this basin will insure 10,000,000 gallons for ordinary and an equal quantity for fire purposes.

The town of Athabaska Landing, to the north of Edmonton, has erected a number of important buildings following the destructive fire of a year ago. These structures include two hotels constructed along the most approved architectural lines, which indicates that the spirit of progress has taken possession of the inhabitants.

Experiments carried on by the Alberta Clay Products Company, Limited, Medicine Hat, are said now to have reached the stage when the right kind of clay mixture has been determined for the production of satisfactory sewer pipes. Many attempts have been made for some time to manufacture the highest grade of sewer pipe in the Canadian West, and apparently success has at last attended their efforts.

An innovation in civic construction work has been suggested by Mr. W. G. Douglas to Winnipeg Board of Control. His plan is to manufacture cement curbing for street paving at the city shops during the winter. The scheme is declared by experts to be quite feasible, and the controllers favor it on the ground that it would provide a good deal of work during the winter, to men who would otherwise be unemployed.

A scenic road is being constructed from Revelstoke, B.C., up Mount Revelstoke to Victoria Park on its summit. Commencing on the western boundary of the city, at an altitude of 1,450 ft., with the aid of five switchbacks, the road reaches the summit, 12.8 miles distant, at an altitude of 6,150 ft. On completion of the road the Canadian Pacific Railway contemplates an automobile service connecting its hotel at Revelstoke with the chalet at the summit, which is to be constructed by the company. The average grade of the road is 6.6 per cent., maximum 7.6 per cent. The park on the summit consists of a plateau of some 70,000 acres.

During 1913 the road construction of the Colonization Road Department reached a mileage of 1,300, entailing an expenditure of $405,351. The northern district which embraces the Rainy River, Sudbury, and other northern districts, received 292 miles of colonization roads and 205 miles of by-law roads, the government bearing the total cost of the former, and of the expenditure of $59,000 on the by-law roads the municipalities in the district contributed $14,000. In the western district which takes in Parry Sound and surrounding territory, 110 miles of colonization roads were built and 80 miles of by-law roads. The figures for the rest of the province give a total length of 292 miles of colonization and 344 miles of by-law roads at an expenditure of $52,000, of which the government's contribution was $32,000.

With other estimates still to be dealt with, the Utilities and Works Committee of Regina City Council have authorized an expenditure of over $2,000,000 for civic undertakings during 1914. The programme is not as large as last year, but in view of general conditions much work that would ordinarily be undertaken will have to stand for the present. That so much work is necessary, in view of the large programme carried out last year, indicates the development of the city during last year. Sewer and water works provide for a large proportion of expenditure, the works in this regard to cost over three-quarters of a million dollars. Street railway extensions have been cut down to a minimum, and only the sidewalk programme left over from last year will be constructed during 1914.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By

HUGH C. MACLEAN, LIMITED

HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.

HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **March 4, 1914** **No. 9**

Principal Contents

	Page
The Organization of Engineering	253
"Mere Accumulation of Building Material" a Cheap Form of Advertising	254
A General Review of Professional and Technical Matters Affecting the Interests of the Engineer	255-260
Satisfactory Tests of Concrete Sewer Pipe	260
The St. Lawrence River Bridge of the Canadian Pacific Railway	261-266
Failure of Concrete Buildings	266
Lay-out of New Water Supply System for the City of Victoria, B.C.	267-270
Freezing Process for Foundations	270
Deleterious Effect of Rust in Steel Highway Bridges By Clifford Older	271
The Preservation of Structural Steel By A. H. Sabin	272-273
Refuse Disposal Practice in Canadian and United States Cities	274
Adapting a New Extension to an Old Building (Structural Features of the Ryrie Building, Toronto)	275
Proposed Windsor Hotel, Windsor, Ont.	276
The New Yorkshire Building, Vancouver	276
New Power and Waterworks Plant, Merritt, B.C.	278
Good Roads Association of Ontario—Report of Twelfth Annual Meeting, Toronto, February 24-26	279
Constructional News	280-282
Canadian Railroad Development	282
Personal Mention	282
Industrial and Miscellaneous	283-284

The Organization of Engineering

IN his recent presidential address (extracted in this issue) delivered before the Society of Engineers, Mr. H. C. H. Shenton pointed out that the profession of engineering requires organizing. As things are now anyone may call himself an engineer, and the word in consequence conveys at the best a confused conviction to the public mind. Mr. Shenton proposes "a controlling body representative of every branch of the profession," and the suggestion calls for the strongest support. Such a movement should, however, be international, or at least, as a preliminary step, embrace all English-speaking nations. Existing societies could maintain their autonomy, although having regard to the deplorable duplication that has marked recent years, much in the way of amalgamation would doubtless follow. The reading and discussion of papers is one of the main features of most societies, and much is said as to the importance of shoulder-rubbing and view-exchanging. How much more advantageous would it not be if meetings could be fully representative and better attended? A civil engineer reads a paper on the installation of a pumping plant. He describes in detail the work in cutting, tunnelling, embanking, pipe-laying and so forth; but he carefully refrains from more than a cursory mention of the pumps themselves for the simple reason that he knows nothing about them except what he has gleaned from the maker's specification. Such a paper might well be the joint production of a civil and a mechanical engineer, and with both civil and mechanical engineers in the audience a full discussion might be expected and the representatives of both professions considerably enlightened. The organization of joint meetings would be an immense forward step, and it could be effected only by some central committee consisting of members delegated by the various bodies represented. How much better organized could not the last International Road Congress have been had the numerous societies and interests concerned in it been regularly in touch with each other! Another very strong point in favor of a central committee—the term "controlling body" is open to objection—is the exchange of "Proceedings." Every society of any importance now issues in book or magazine form the papers presented to it, but each society jealously confines the circulation of its publications to its own circle. It would surely be of benefit to, say, the Canadian Society of Civil Engineers if those members who so desired could receive regularly the "Proceedings" of the Institutions of Civil, Mechanical and Electrical Engineers; and the converse would apply equally. The expense need not be great, while the educative advantages would be incalculable. The engineering profession is, in fact, split up (with quite a few exceptions) into a number of ineffective bodies, which are for the most part merely mutual admiration societies. And meanwhile, there exists an untrained horde of incompetents, who by push and effrontery, bustle and bluff, divert the fees from the legitimate pockets. In the "letters" contributed by our London correspondent it has been shown how an electrical engineer can attain the premier highway engineering post in England the while good men, of the highest ability, languish on a road foreman's wage.

It is estimated by a United States firm that the loss in cement which adheres to empty cement bags, or is shaken out into the air, amounts to about $300,000 a year. In order to enable cement manufacturers to obviate this loss, a dustless, cheap and efficient method of cleaning bags has been introduced by the Century Cement Machine Company, of Rochester, New York. The machine employed is of simple construction, occupying little floor space and capable of being worked by a boy if required. Every bag is counted as soon as cleaned, and after fifty bags have been cleaned a bell rings to notify the operator.

"Mere Accumulation of Building Material" a Cheap Form of Advertising

WHAT was described as "mere accumulation of building material"—to wit, the modern skyscraper—together with the tendency to seek this cheap form of advertising, was discussed editorially in our issue of January 28 last. It is possible that many members of the architectural profession refrained from taking part in the discussion for fear that they should go on record as being opposed to this class of structure and possibly lose thereby. It might be pointed out in passing that reticence of this kind is rather a sign of weakness than of strength, for it is fair to assume that if a man never gives expression to his views his opinions are unstable.

Interesting comment on the subject was submitted by the well-known Montreal architect, Mr. Philip J. Turner, F.R.I.B.A., whose letter published in our issue of February 18 was a well-considered statement of the pros and cons. Mr. Turner made a strong plea for uniformity of treatment in the design of buildings and for careful planning in the layout of our cities.

In our editorial article we cited the example of the United States as something to avoid—that is, in regard to the erection of high buildings in congested spaces. For this reason we cannot very well overlook an editorial consideration of the subject given in a recent issue of the Engineering Record. It will be noticed that our contemporary favors a maximum height of one hundred feet. That such a recommendation should be made by one of the leading constructional journals of New York City—the home of skyscrapers—is particularly suggestive of reform and encouraging to those who desire to see Canada built up upon rational and hygienic lines. We quote our contemporary:

> "One would think that the recent publicity given to building-height limitations would have awakened cities throughout the country to a realization of the need for appropriate enactment: Detroit has heard and is considering a height-limitation ordinance. Minneapolis is either in blissful ignorance of the danger to its civic future or prefers advertising to sensible civic development. The tallest completed building in Minneapolis is twelve storeys, about 150 ft. high, but one reaching 200 ft. is to be started the first of May. Unless all previous experience is contradicted, then will begin the senseless rivalry as to height, and some competitor of the owners of the proposed structure will show that they can "go them one better." Minneapolis is known far and wide as an unusually fine city—one endowed with natural advantages and blessed with wide streets and good transportation facilities. The more's the pity that it should endanger its good reputation by courting the congestion in street traffic and overtaxing of transportation facilities inevitably accompanying excessive building heights. The present maximum, 150 ft., is a good point at which to stop. There is no excuse for exceeding it. It is contended in all cases that land values require high structures in order that there may be a fair return on the investment. That, however, is the starting point of a vicious circle—tall buildings increase land values; increased land values require higher buildings; these higher buildings still further increase the land values, and so on. Another argument advanced in favor of the tall building is that a compact business district is a necessity if a town is to be commercially important. That idea has been exploded by New York's expansion. The business district now stretches from the Battery to Forty-second Street—4 miles—and the section farthest from the Wall Street district is growing at the greatest rate, showing that its 3-mile removal from the former hub is not detrimental. The proposing offender at Minneapolis is a bank—the class of institution that most quickly responds to appeals for the support of civic projects. It has an unexampled opportunity to show its civic patriotism—by abandoning its 200-ft. monster and keeping within the present maximum limit. If its civic patriotism is unequal to such a sacrifice, the municipality should lose no time in passing a height-limiting ordinance, so that imitation may be impossible or may be checked as quickly as justice dictates.
>
> "What has been said above about Minneapolis in the preceding note applies with equal force to many aggressive cities throughout the country. Particularly in the southwest is there danger of unnatural striving after advertising through high buildings. In such places as Muskogee, Oklahoma and Dallas, Texas, the number of tall buildings in relation to the land values is astonishingly large. These cities, and many others like them—notably the thriving Lake cities—still have their civic futures before them. They can make places of beauty or, like New York and Chicago, can advertise in haste and repent at leisure. Experience in the New as well as in the Old World is against the tall structure. London, Paris and Berlin have as much reason for the tall building as New York or Chicago. They have refused, however, to allow the vicious-circle argument to be started and have held their maximum height to less than 100 ft. This limit may well be adopted in all American cities which have not already gone so far beyond this mark that retreat is impossible—and now is the time to do it."

An electrical process for purifying clay, brought to the notice of the English Ceramic Society by Dr. W. R. Ormandy, depends upon the fact that clay is electro-negative, while its chief impurities are electro-positive. The emulsified clay is partially coagulated by adding electrolytes, and is further purified by passing through a vessel having electrodes differing by 60 to 100 volts. The clay substance, with as little as 18 to 20 per cent. of water, is deposited as a continuous blanket four and one-half feet wide and a quarter of an inch thick. Even fine particles are removed, and the solid product may contain as much as ninety-nine and five-tenths per cent. of china clay.

The highest tower hitherto erected for the distribution of concrete by gravity is one, 203 ft. 3 in. high by 6 ft. square, now being used in the construction of a railway viaduct in Baltimore. The tower is entirely of timber, the hoisting buckets, each of half a cubic yard capacity, discharging into 10 in. spouts, 350 ft. long, through which the concrete flows directly to the moulds where required.

According to an official statement issued recently, there are something like 330,000 unemployed men in New York City at the present time. These include 140,000 unskilled laborers and 70,000 workers in the building trade.

A General Review of Professional and Technical Matters Affecting the Interests of the Engineer

ONE of the ablest and most comprehensive treatises of the kind that we have had the pleasure of reading is the presidential address delivered last month in London before the Society of Engineers by Mr. H. C. H. Shenton. We make no apology for the copious extract given below, for Mr. Shenton's observations constitute a careful analysis of the broad principles of engineering, and these principles find a common level in both England and Canada—and the world over for that matter. The leading editorial in this issue is devoted to one of Mr. Shenton's topics, the organization of engineering, and it is to be hoped that readers of this journal will take full advantage of the invitation which we now extend them to contribute their views.

Of the other important matters considered by Mr. Shenton, special importance attaches perhaps to the real economy of scientific treatment and the necessity of employing only thoroughly competent engineers. A great deal of public money has been wasted in Canada owing to shortcomings in the designs prepared by small-salaried men of general experience in cases where specialists should have been called in. The history of our larger municipalities is a record of inefficiency in the handling of water and sewage. We are all quick to blunder and slow to learn: Canada has been particularly slow in learning that the best is the cheapest.

Every paragraph in Mr. Shenton's address affords food for reflection. The systematic hydrographical survey that he urges is something which might be considered here. His remarks concerning the consulting engineer are suggestive to Canadians. The economy of the best professional assistance is illustrated by the failure of certain structures in this country.

The proper value to place upon the advice given by manufacturers is not the least important of the remaining topics of an address which is deserving of the careful study not only of all municipal engineers but of all those others who have a part—or a pretended part—in municipal administration. Our extract follows:

There are many signs that there is need for better organisation in the profession. This is to be observed both in England and in America, and a great deal of consideration has been given to the matter; but at the present time many of the efforts made are individual and spasmodic, the work done by the largest body of all—viz., the Institution of Civil Engineers—being, in a great measure, unknown to the vast body of engineers. Some societies make such work the nominal object of their existence, and incidentally it may be observed that the mere existence of any society of engineers should tend in the direction of proper organisation of the profession, for the first rule of that society should be that its members shall be engineers.

Engineering is an honoured profession, and good engineers receive quite as much consideration and respect from the general public as they either desire or deserve. No better organisation of the profession will increase the respect with which a properly trained and qualified engineer is regarded at the present time. There is nothing in the profession as it stands which makes it in any way less honourable than the highest professional calling. The trouble is that the general public often regard persons as engineers who have absolutely no claim to the title, such persons being allowed to call themselves engineers without hindrance.

The Society of Engineers is at the present time devoting considerable attention to the subject referred to—viz., the organisation of the profession, and the well-being of the engineer—and will spare no pains in the future to promote this object. Such work is being considered not as an isolated effort in opposition to what is being done in the same direction by other societies and institutions, but is taken up with the object of ultimately securing a combined effort of the whole profession, and the formation of a controlling body representative of every branch of the profession, which would thus be in a position to accomplish effectively the reforms which are generally admitted to be necessary. This is not a selfish undertaking done simply for our own honour and glory, neither are we arrogating to ourselves a right which belongs equally to other societies, but it is a genuine effort to increase the interest of engineers in a movement to their own advantage, and to support loyally any satisfactory effort that may be made by others.

Although there is nothing wrong with engineering as a profession, there are a great many difficulties with which the engineer has to contend which come under consideration. The employment of persons who are not engineers to do engineering work is one of them; the employment of engineers at an improper rate of payment is another—to give only two instances. In the legal profession no unqualified person may practise as a solicitor under a penalty, yet in the engineering profession, where human life is sometimes dependent upon the work, no such safeguard is to be found. It is quite a common thing to find an overworked surveyor in a rural district receiving a salary of perhaps £60 or £70 a year, dealing with the spending of very large sums of money on purely engineering work. If the profession were properly organised such a person could not be found. If he were competent he would not be allowed to work for insufficient pay, and if he were not an engineer he would not be allowed to do the work.

I would therefore urge that all engineers, whether they are members of this society or not, should regard the serious effort that is being made for the better organisation of the profession, and that they should assist us by bringing matters pertaining to the subject to our notice and by working in friendly conjunction, and should remember that we, as a society, are anxious to assist them in anything that can have a useful bearing on the subject.

Waste of Public Money

Much public money is wasted owing to these causes, and taking only one expense—viz., that of the work done by local authorities by persons who are not engineers—the fact is perfectly plain, and it is therefore necessary in the public interest that engineers should combine in the endeavour to make it impossible that their work should be given to persons outside the profession. Again—and here I speak on my own subject—it is equally important that such works as those of sewerage, sewage disposal, and water supply should be carried out by engineers who have special knowledge and experience of these particular subjects. At the present time this country is full of instances where the public money has been wasted by the construction of works which are quite unsuitable for their purpose. If the list of failures in sewage disposal works and in water supply works were recorded, together with the names of those responsible for the work done, the result would be very instructive.

Again, this appears to be an age in which any person, without respect to his qualifications, may pose as an authority, and write a text-book for the use of students. There are to hand at the present time examples of recently published books on engineering matters, and especially upon the subjects of water supply and sewage disposal, which are full of obvious errors. Such books may be useful enough to the engineer of experience who can discriminate between right and wrong, but it is grossly unfair to the student to put into his hands a text-book calculated to lead him astray. It seems as if all that is required at the present day is for a person to make an assertion. The assertion goes forward, frequently without comment, as a fact, and becomes a source of error. The authority is generally unquestioned. This is an unreasonable attitude on the part of the public, including sometimes engineers. If a great engineer of world-wide reputation makes an assertion, that is merely his opinion, but we have it on good authority, and it is therefore of great value; but if an unknown person of inconsiderable attainments writes a book and makes various hard-and-fast rules and assertions, these ought not to be allowed to go forward for the guidance of students without proof. It seems as if some sort of Press censorship is desirable. A department might be formed for the careful reading of new books written by unknown authors, with a view to their inclusion in a list of text-books suitable for students preparing for examinations. Naturally, when a student visits such a library as that of the Institution of Civil Engineers, he is inclined to regard the books in that library as having received the approval of the institution, whereas such libraries receive books both good and bad. I have certainly come across books and writings recently which bear traces of the mental aberration of the author, but such books frequently receive no proper criticism in the engineering press, and may be accepted as among the number of ordinary text-books.

Again, some of these books are written, if not by manufacturers themselves, by those who appear to be willing to advertise the goods of a special manufacturer. A book upon water supply, for instance, may, under the heading of "Water Purification," speak of a certain make of mechanical filter as if that filter were the only one of its kind, and may entirely omit to mention the large number of other methods which exist for the purification and treatment of water.

Water Supply

At the present time there are certain definite lines of policy that are observed in connection with water supply, and certain principles have also been accepted which will have a far-reaching effect upon engineering work in the future. These are of various kinds, and are the outcome of general experience, research work, the work of the Royal Commissions, and other causes. It has been established within the last few years, and has been definitely confirmed by the Eighth Report of the Royal Commission on Sewage Disposal, that water authorities must be responsible for purifying waters drawn from a river, while the local authority discharging sewage into a river need only purify that sewage to such a degree as to prevent actual nuisance.

It is also now generally acknowledged that there is need for the collection throughout the country of data as to sources of supply. A systematic hydrographical survey is required. We need to have fuller particulars with regard to rainfall, the run-off of the land, and the yield of streams and rivers. The formation of a central authority and of water boards is required so that the national supply shall be considered as a whole, and although legislation is slow, there can be no doubt that we shall ultimately obtain what is required, and that eventually the whole matter will be administered much more satisfactorily and economically than is at present the case; for it is obviously very wasteful when one large community, which happens to be divided into two or more districts, is allowed to spend money upon two or more separate schemes, when one large scheme would have met the requirements of the case much more satisfactorily. The combination of districts is to be desired; the appropriation of the sources of supply and gathering grounds by one water authority to the detriment of others is to be deprecated, and the enormous expenditure of money, owing to the conflicting interests, that takes place whenever any scheme is brought forward, ought to be avoided. As things stand at present it is generally acknowledged that reform is required.

Economy of Scientific Treatment

Another even more important point that has not yet received the general acceptance that it will receive in the future, is the absolute need of water supply problems being placed in every case in the hands of those who can deal with the matter scientifically, making use of the most recent knowledge and experience on the subject.

It is becoming more and more evident that the engineer must work with the chemist and bacteriologist. To give a few instances: If the water supply of London had not received this thorough attention we should long ago have had to abandon our present sources of supply, and enormous expense would have been incurred in bringing water from a source further afield, but owing to the fact that the whole question has received the very best attention, we have a combination of districts, a reduction of waste, a water drawn from sewage polluted rivers rendered fit for drinking purposes, and what would at first sight appear to be quite impossible brought to successful fulfilment. The same thing applies exactly in other cases. For though the smaller works are of less importance, regarded collectively, from a national standpoint, they are of greater importance even than the supply of London. It is not sufficient for the engineer to obtain a supply of water free from disease germs, obvious pollution, discoloration or objectionable mineral constituents. A water which is apparently desirable in every respect may yet cause very serious corrosion in mains, and algal troubles in the reservoirs, may be productive of animal and vegetable growths in the mains, and may clog the filter. The conditions need to be much more carefully considered than has formerly been usual, and in this the engineer needs very considerable assistance from the chemist and bacteriologist. We are well aware that hard water may be softened, and the fact that plumbo-solvent waters may be treated with lime so as to remove this quality is fairly well known, but it is quite a new idea and one that was only recently brought forward in a paper read before this society by Dr. Eric Rideal, that a water may be treated in such a manner as to provide a protective coating to the interior of an iron main, so that corrosion shall not take place. In a report issued by the Institute of Metals such treatment of water was recommended in connection with boiler tubes, but it did not appear that anyone had suggested that it could be applied satisfactorily in the case of water mains. The protection of the interior of water pipes is not an easy matter, and if it can be effected by the treatment of the water it is clear that there will be a saving of expense, because this treatment would only be required at long intervals of time.

The manufacturers and patentees of various processes act upon scientific advice in many cases, but they are naturally special pleaders for their own particular systems, and as commercial men cannot be expected to give the disinterested advice that is given by the private engineer. Unfortunately it is quite a common thing for work to get into the hands of persons who, possessing insufficient knowledge, rely entirely upon advice obtained from manufacturers. This is particularly so in the case of water treatment, and it is also true to some extent in the case of other matters, such as reinforced concrete, which matters will be again referred to.

It has hitherto been generally taken for granted that if a certain water produces corrosion or clogging of iron mains, the only cure for the difficulty would be to put in mains which are of such a character that they will not corrode. Thus pipes are coated with preservative solutions, sometimes with Portland cement, metallurgists seek to find a metal which will not corrode, reinforced concrete pipe, wood stave pipes, and so forth are suggested, but all recent experience tends to show that it is not so much the pipe which is at fault as the water, and that if the matter is dealt with scientifically the corrosive qualities can be removed. This is but one example of the importance of the question being dealt with as a whole carefully and separately in each case, by the best scientific advisers, including engineers, chemists and bacteriologists. In cases where underground supplies are in question it goes without saying that the assistance of the geologist is also required.

The Consulting Engineer

On small works the work of the engineer-specialist, the consulting engineer proper, ought to be very carefully distinguished. It certainly seems that the use of the consulting engineer on such work is not properly understood by his clients. Such an engineer is called in to prepare a scheme, and to advise as to the expenditure of a large sum of money to the best advantage. Unless he has considerable knowledge and experience he cannot do such work. It is work of the first importance, and should be highly paid.

As a striking example of the folly of approaching waterworks problems unscientifically may be instanced the large number of dams which have failed in America and elsewhere. In most cases these failures have been due to lack of geological knowledge. The dams themselves have been quite strong enough to withstand the water pressure, but the water has managed to find its way underneath them. We have many instances in this country as well as abroad of the difficulties which have occurred owing to the particular geological conformation of the ground.

It is wrong to take the view that the engineer can be a specialist in all subjects, and it is perfectly correct, for instance, for the municipal engineer to call in the consultant to advise him or his council in case of need, in the same way as the town clerk will require to have counsel's opinion upon any difficult point of law, and it is also perfectly correct for the consulting engineer to require the advice of other engineer-specialists, of chemists, geologists, bacteriologists, and so forth, as the case may require. If the profession is to be properly organised, the consulting engineer ought not to undertake personal work for which he does not specialise. It will at once be urged that under such conditions it might be impossible for him to earn a living; but this is not so, for if each man undertook to do only the work for which he was specially fitted, and if other engineers refused to do that work, it stands to reason that he must of necessity receive a great deal more of his proper work, and that he would do this with greater advantage to himself and to his clients than could possibly happen in the case of work that rightly belonged to some other engineer. He would have to pass on such work as he was not personally well qualified to do, and for which he has even now to pay away the bulk of his profits to skilled assistants, if he carries it out properly. It is still worse for an engineer to take up work which he does not understand, and to obtain advice from manufacturers who, in some cases, even go so far as to call themselves consulting engineers.

Advice Given by Manufacturers

These manufacturing firms employ expert assistants, but they give designs and advice free of charge in order to sell their appliances, and although they, the manufacturers, may receive disinterested advice from the engineers whom they employ they must recoup themselves, and if they, as commercial men, do not give disinterested advice they cannot be blamed. This is particularly the case with regard to reinforced concrete. Many persons, having a reinforced concrete structure to build, obtain their designs free of charge from the manufacturers of reinforcing material. If they possessed the knowledge required they would design their own structures, and if they cannot do this they ought to consult a specialist and work with him, and pay him for his advice. The Local Government Board have very properly raised very serious objections to the reinforced concrete designs brought forward by the officers of local authorities when it was perfectly clear that such officers had a very imperfect knowledge of the subject, and relied entirely upon advice given by manufacturers.

Similarly in water purification or sewage disposal there are many instances of persons obtaining direct from manufacturing firms designs which may or may not be the best for the purpose, but which of necessity are designed by the manufacturers in order to sell their particular appliances. If this system of obtaining designs free of charge from manufacturers is to be admitted as being in conformity with the rules of the engineering profession, it follows that any person of organising capacity, however limited his knowledge of engineering may be, may carry out very large works which are really designed by other people, and about which he is quite incompetent to express an opinion, and to charge the full fees of a consulting engineer for doing so. Moreover, the system is most unfair to the manufacturers, who, in order to keep their trade, must prepare a very large number of designs which are never used, without making any charge for them, such designs frequently being required merely for estimating purposes. If the profession recognised its responsibility in such matters, and could educate public opinion in the right direction, there would be a great saving in time and money to the manufacturer, and only the properly qualified engineer would be able to take up work.

Recent Developments in Water Engineering

Of recent developments in water engineering the various methods for the treatment and purification of water are very remarkable. The possibilities seem almost infinite, as if there were no water, however impure, which could not be raised to a high standard of purity by adequate treatment. The growing practice of purifying swimming bath water, and using it over and over again for months demonstrates extraordinary possibilities. It has been found that, after many months' use, water so treated is quite equal in quality to the ordinary town supply. The use of the mechanical filter, together with chemical treatment, has increased enormously, and there are many instances of the employment of such filters dealing with several million gallons a day, some of them being in this country. There are also many other filters of various types which have their uses according to special conditions, and the slow sand filter is still very largely employed. Sterilisation of water by means of hypochlorite has been very generally adopted in America, and also, to some extent, in this country, notably as an after treatment with the mechanical filter, and there is abundant evidence to show that the typhoid death-rate has been lowered, and sometimes lowered to zero, as the result of this treatment. Ozone sterilisation is in use on the Continent at a good many large installations, and the ultra-violet rays have also been applied to the sterilisation of comparatively large town supplies in France. It cannot be said that these methods have made much headway in this country, the reason being that our supplies as a rule, are not open to the objection of gross pollution. It is, however, notable that Dr. Houston has advised the Metropolitan Water Board to sterilise the flood waters flowing into the storage reservoirs by means of an overdose of lime, and it is also notable that the ordinary lime treatment seems to include sterilisation apparently unsuspected hitherto, at any rate in some cases.

The Work of State Departments

The value of hydrographical surveys and of State consideration of water supplies is shown at present chiefly by the work done abroad. The work in America is well known, while in our own Colonies we have such examples as the case of Western Australia, where the State engineer, having reported a large sub-artesian basin existing under the drier districts, boreholes were sunk throughout the sandy plain, with the result that good supplies were secured at depths of from 20 ft. to 100 ft. The good work was assisted by the Government, who lent the settlers hand-boring plant. Thus great advantages were derived and many wells and reservoirs were made. It is questionable whether the same degree of praise is to be given to the German Government, who recently sent a water diviner to South Africa "to practise under State patronage the cult of the divining rod."

Pumping

One of the most important changes in connection with water engineering has been in pumping. The use of the high speed engine, the steam turbine, the internal combustion engine, and the electric motor has resulted in the development of the rotary pump. Centrifugal pumps are now largely used, and by running in series are found to be efficient and useful for very high lifts. Producer gas is found to give economical results for large and small powers, and its application is very marked. Further, we have the Humphrey explosion pump, which does away entirely with the engine and most of the working parts of the pump. This pump is also being used for sewage lifting, and apparently has an application for both small and large supplies where a moderate lift is required.

Water Waste

An interesting point relating to some of the older systems supplied from new sources under great pressure is the effect which a largely increased pressure has upon the old mains, services, valves and fittings. This is particularly the case with regard to New York, where it is feared that the increased pressure may lead to a considerable loss of water from various causes. It is certainly a point to be borne in mind where a new supply at a higher pressure is provided. In London we have a splendid example of what may be done by careful inspection and scientific management in reducing the loss of water due to waste, but such methods, are not by any means universally adopted. In American cities the waste is apparently enormous, and a great deal of interesting work is being done in order to reduce this waste. The pitometer is a simple instrument which has been proved to be exceedingly useful in measuring the flow in water mains, and by its use a great deal of waste has been discovered. Great carelessness is sometimes shown in this country with regard to waste. In one instance within the writer's experience a small town whose population had not increased in any marked degree since the waterworks were constructed, found it necessary to duplicate its well, reservoir and pumps owing to the insufficiency of the supply. It was clear, however, that enormous waste was taking place, and eventually a 4-in. main was discovered at the lowest part of the system broken in half, discharging into the river, but the great point is that this discovery was not made until the works had been duplicated.

Water Mains and Reservoirs

The use of steel mains is largely on the increase, and appear to be taking the place of cast-iron mains in a great many cases.

With regard to reservoirs, the chief advance is in connection with reinforced concrete, which is undoubtedly a very economical and useful material.

One of the most noteworthy features of recent practice is the increased use of cement injection. We see, for instance, in the case of the Catskill aqueduct, that the pipes were made of concrete, and that these were made watertight by systematically injecting cement grout under pressure behind the walls of the tunnels. There are several instances where extensive fissures causing leakage under reservoir dams have been satisfactorily filled with cement grout forced in under pressure through borings. The same method is sometimes adopted in order to form masses of concrete for foundations where clean gravel exists under water. Some interesting experiments have recently been carried out with regard to this matter. The rendering of surfaces by means of the cement gun, wherewith cement is thrown out under pressure from a nozzle and applied to the surface to be treated is worthy of note. The method has also been used for lining large pipes.

With regard to the storage reservoirs and the construction of dams, recent progress shows that very much more attention is being given to geological considerations than was formerly the case, and that it is worth while to give very much greater attention to preliminary investigations with regard to the site of the reservoir, and to prove by every possible means its suitability before starting the work. Sir Alexander Binnie, in his recently published book, has laid the greatest stress on this point.

Dr. Houston has shown in the case of London that storage reservoirs may be used for water purification, it being found that a few weeks' storage is sufficient to kill or to devitalise harmful germs. The method is hardly likely to be very generally applied, because the water probably does not need such purification, and, moreover, the cost of constructing the reservoirs makes the system prohibitive in the majority of cases. There are also possibilities of trouble with regard to algal growths in the water.

Sewerage and Sewage Disposal

With regard to sewerage and sewage disposal, we are in a much more satisfactory condition than was the case only a few years ago when practically no attention was paid to the question of whether a nuisance was caused by the discharge of sewage or not. The publication of the Eighth Report of the Royal Commission, shows that this matter has received considerable attention. The officers of the commission, as will be seen in the Appendix to the Eighth Report, suggested that the quality of the sewage discharged was not the chief matter to be considered, but that the stream itself ought to be the ultimate arbiter in the case. Thus, if a stream or river, after the discharge of sewage or effluent into it, were found to be unharmed—that is to say, if it showed no signs of nuisance, and if it retained a certain degree of dissolved oxygen—this should be taken as proof that the sewage required no further treatment. Further, experiments carried out with great care showed that if sufficient dilution were given to screened sewage entering a river, purification was effected by this dilution. The commissioners did not actually adopt this suggestion made by their officers, but advised that the law should be altered so that a person discharging sewage into a stream should not be deemed to have committed an offence, provided that the sewage conformed to a certain standard. They suggested for this general standard that the sewage discharged should not contain more than 3 parts per 100,000 of suspended matter, and with its suspended matters included should not take up at 65 deg. Fahr. more than 2 parts per 100,000 of dissolved oxygen in five days; but they also advised that special standards, demanding either a higher or lower degree of purity, should be made applicable as local circumstances might require or permit. Thus, if the dilution afforded by the stream were very low, the standard would have to be raised, but if the dilution were very great the standard might be relaxed or suspended altogether, and that if the dilution should be over 500 volumes all tests might be dispensed with, and crude sewage from which the solids had been removed might be discharged. These are most important recommendations, and will no doubt be acted upon at some time in the future.

Bacterial Pollution of Rivers

Experiments in the Great Lakes of America have shown that harmful bacteria from sewage may be carried out for several miles from the shore, and may contaminate water at intakes situated in places which one would imagine to be in absolutely safe positions. The Royal Commissioners do not say anything about the possibilities of bacterial pollution in their Eighth Report, but it is probable that in the case of the American outfalls the reason why harmful bacteria are carried to such great distances in the water is because the sewage is unscreened; for it is certain that with floating solid matters there is no limit to the distance to which disease germs may be carried, and this may account for the many serious typhoid epidemics in America, while we in London, drinking water which is admitted sewage polluted, apparently suffer no ill-effects, and typhoid germs are not found even in the raw waters.

Stand-by Tanks

One of the most useful recommendations contained in the Fifth Report of the Royal Commission was that referring to the use of stand-by tanks for storm water at the disposal works. In the older works filters were generally designed to deal with a certain volume flowing down at a certain rate, and every time this rate of flow was exceeded the sewage escaped over the storm overflow. Now all such sudden rushes are either dealt with partly on the filters, and any excess is intercepted in the stand-by tanks for further treatment.

General Purification

The usual principle at the present time is that of keeping back the sludge by screening, settlement or precipitation assisted by the use of chemicals, so that an effluent containing as little suspended matter as possible has to be treated by the filters. The treatment of this liquid is a matter which has been brought to perfection. It can be filtered and treated till it conforms to any required standard of purity, the degree of purity being limited only by the degree of treatment given. If, owing to exceptional conditions, it is necessary to sterilise the effluent, this can be done without any great trouble, as is practically demonstrated by various works where it has been adopted. It may be added that, although when the sterilisation of sewage was first suggested the idea was ridiculed, the process is now among generally accepted methods, although it is very rarely that there is any need to apply this process. It has been found possible to construct filters of various types in such a manner that they do not clog up. The black, earthy matter that forms in a well-designed filter which has been properly worked is discharged with the effluent, and can be intercepted in settling or humus tanks, which tanks, if properly designed, are very effective in clarifying the liquid.

Slate Beds and Contact Beds

The value of the Dibdin slate bed has been proved, as may be seen in the Seventh Report of the Royal Commission on Sewage Disposal. It is there shown that such beds dealing with crude sewage will, if properly worked, retain their original capacity for an indefinite period, provided that the sludge is regularly and carefully run off. The slate bed thus answers the purpose of the settling tank; but it does more, for, putting aside the question of the reduction of the sludge in volume, it is found that the slate-bed sludge "possesses only a slight odour," and this statement is quoted from the Royal Commission Report. It is much to be regretted that, owing to the simplicity of the principle upon which they work, the slate bed and the contact bed have very often—one might almost say generally—been badly constructed and improperly worked. Thus bad results have been produced, and discredit has been thrown upon a system which should be of very great value to the engineer. The author having constructed many contact beds in different parts of the country, and carried out a considerable number of experiments both in working and construction, during the last ten years, has found that, with proper working, contact beds will give excellent results, and are specially useful for the treatment of sewage containing a large proportion of brewery refuse. Further, it is possible to fill the beds in such a manner that no crude sewage or effluent likely to cause a smell is exposed to air, and thus one of the chief troubles of the sprinkler filter is overcome. It is not suggested that contact beds are better or more economical in construction than sprinkler filters, but it is suggested that under many conditions, especially at small works, they will be found to give very much more satisfactory results. This presupposes that the same amount of care as is generally given to the construction and working of the filter is given to the contact bed. The nuisance from smell experienced with the sprinkler filter is in the majority of cases not very great, and, as a rule, freedom from smell may be attained by careful preliminary treatment.

Tanks

It would seem that, having regard to the recommendations contained in the Eighth Report of the Royal Commission, the settlement of sewage and various methods for the elimination of sludge will receive even more consideration in the future than they have done in the past, and that filtration may not always be required. Tanks of many kinds are in use, such as the septic tank, the continuous flow sedimentation tank, the quiescent sedimentation tank, chemical precipitation tanks, the hydrolytic tank, and a large number of others too numerous to mention, and it seems probable that, in the future, tanks of the Imhoff type will be largely used. In this type of tank the object is to allow the fresh liquid sewage to pass through rapidly so as to avoid septic action, while the solid matters are retained and held in a separate chamber, where they remain for some time, being drawn off, without emptying the tank, at convenient intervals. It is found that the sludge, after retention in such a tank for a certain time, loses much of its offensive character, and is thus comparatively inoffensive when it is drawn off; but here, again, the whole process is dependent upon careful management.

Sewage Lifting

The lifting of sewage is also a matter in which considerable interest is displayed. The centrifugal pump has been improved to such a degree that it will lift even large blocks of stone. Naturally, the efficiency is not very great under such circumstances, but attention is drawn to the matter in order to show that there is every reason for the growing practice of employing centrifugal pumps for sewage lifting. The use of the small electrically driven centrifugal pump is also noticeable in isolated positions where it performs the work of an ejector, being automatically controlled. This electrical arrangement has been much improved, and it is rather remarkable that so little is heard of it having regard to the remarkable activity upon the part of manufacturers of sewage ejectors. The automatic sewage lift is, under the right conditions, by far the most economical appliance in use.

The Parsons stereophagus pump, a centrifugal pump designed especially for sewage lifting, is also worthy of note.

Sewer Ventilation

The report of the Local Government Board on the intercepting trap tended to demonstrate the comparative harmlessness of sewer gas in general. If the teachings of this report, which has been much criticised, are accepted, it appears that very little more is required in the ordinary system of sewers than to arrange that there may be no pressure of gas in the sewer, which, as a matter of fact, is really all that is done as a rule in any ordinary town system. It does not justify any relaxation in the efforts made to ventilate sewers, but it is some consolation to be told that the dangers of an ill-ventilated sewer are not so great from a health point of view as was generally believed. The abolition of the intercepting trap suggested is an accomplished fact in some places, which seem none the worse for the change. Whether the principle is of universal application is another matter.

Effect of Traffic

The altered conditions of road traffic and the enormous loads which now come upon road surfaces, and upon manhole covers in particular, should be taken into careful consideration by engineers. There is increasing need for soundness of construction of sewers and manholes and for strength in manhole covers.

Satisfactory Tests of Concrete Sewer Pipe

INSTRUCTIVE details concerning the testing of concrete sewer pipe are furnished by E. S. Wallace, Cement Inspector of Kansas City, who presents some interesting conclusions in a recent report. At Kansas City reinforced concrete sewer pipe 30 ins. and 33 in. in diameter and plain concrete sewer pipe from 10 ins. to 24 ins. in diameter are in use. The cost of the reinforced pipe is $1.50 and $1.90 a foot and of the plain pipe from 17c to $1.06 a foot. Plain concrete pipe up to 12 ins. in diameter is of cement and sand 1:2½. Larger pipe may be of the same mixture or of 1:1:2. The conclusions are as follows:

Our tests have shown conclusively that there are three things essential to the manufacture of good concrete pipe: 1, the pipe must be composed of proper materials; 2, it must be made right, and 3, it must be cured right. Too much emphasis cannot be placed on the fact that curing is as essential as the materials from which the pipe is made, or the method of manufacturing, for it is possible for a manufacturer to exercise all the care possible in the first two matters and ruin the output of his plant by improper curing.

After the molds have been removed the finished pipe should be kept thoroughly moist and at a temperature of about 70 deg. F. for at least 10 days, and in extremely hot or cold weather it should not be exposed to the elements for a much longer period.

During the winter of 1912-13 considerable difficulty was experienced on account of improper curing. The storage sheds were heated with stoves, and pipe placed too near them dried too rapidly while those near the sides of the shed were retarded in setting on account of the cold. It was expected that when warmer weather arrived this difficulty would be overcome, and this was the case to some extent until the extreme dry hot weather came. Then, as the storage capacity was inadequate, large numbers of pipe were placed in the yard, exposed to the air and sunshine, before they were properly cured. This was found to be as great (if not a greater) detriment than the cold weather.

The writer has made experimental tests on a number of 8-in., 10-in. and 12-in. pipe of 10 days age, that were properly cured up to that time, which have resisted from 60 lb. to 90 lb. internal pressure without showing any signs of seepage or percolation. Pipe of the same size and made under the same conditions, and of much greater age, but which had been stored in the open and exposed to the elements, have repeatedly failed below the specification requirements. The manufacturers of these pipes use no waterproofing, and hundreds of tests have demonstrated that none is required where materials are carefully selected and proper care is exercised in manufacturing and curing.

During the year we have made 530 tests on concrete pipe ranging in size from 8-in. to 24-in., 411 (or 77.55 per cent.) of which passed both percolation and pressure tests. This does not represent the percentage of loss of the output of the plant, as most of the failures occurred during July, August and September, when the weather was extremely dry and hot.

We have practically abandoned the compression tests, as we have never found a pipe of either clay or concrete that failed below specification requirements. There is but little difficulty experienced in handling concrete pipes, as they are not brittle and resist considerable impact before fracturing.

The pipes are made on a machine having four revolving tamping bars, eccentrically worked and striking 300-lb. blows at 150 blows per minute. The core works on a revolving screw and remains stationary during the tamping; then it is started and after making a sufficient number of turns to trowel the interior, it drops below the floor. This trowelling of the interior is important and when the pipe is properly made it has the smooth glazed finish desirable for sewer work. The concrete is a dry mix, fed from an overhead bin through a 3-in. pipe and deposited directly in front of the tampers.

The finished pipe is taken to the curing shed, where it is placed on end and the mold is removed. It is strong enough to stand without allowing additional time for the cement to set. It is kept moist for about ten days before being removed to the storage yard. The concrete is of a consistency that will barely hold together when pressed firmly in the hand, and after the molds are removed the "water web marks" show plainly over the exterior. Our tests have demonstrated that when the mix is so dry that these marks do not show, the pipes show seepage or percolation on test and usually fail at a low pressure.

In 1912, Kansas City laid over 35,000 lin. ft. of plain concrete pipe, and in 1913 over 75,000 lin. ft. in sizes ranging from 8 in. to 24 in. There have been no failures.

The Berlin city council has passed a resolution urging the government to put Goderich harbor in proper condition for entrance in all kinds of weather. The construction of a deep waterway from the Atlantic to the head of the Great Lakes was approved, and it was also decided to request the government to give Western Ontario and the prairie provinces full representation on the proposed Georgian Bay Canal commission, and that the investigation cover the entire route of Georgian Bay to Montreal.

A gravel bed has been discovered at the head of Stag Island, in the St. Clair river, a few miles from Sarnia. In the opinion of an expert the deposit is what is known as a gravel spring which brings gravel to the surface as fast as it is carted away. The local council has forwarded a resolution to the Hon. Robert Rogers, Minister of Public Works, expressing the opinion that the gravel rights should be withdrawn from the private company and taken over by the Provincial Government, in the interest of Sarnia and other Western Ontario towns.

The Toronto Chapter of the Ontario Association of Architects recommends the division into two parts of the City Architects' Department, one to be for the superintendent of buildings, with full charge of all inspection work; the other, an Architects' Department proper—to have charge of the designing work for the city. The superintendent of buildings would have his department divided again into seven sections, a superintendent-in-chief being recommended over each section with inspectors of each class of work under him.

The St. Lawrence River Bridge of the Canadian Pacific Railway*

Features of Design and Construction

By P. B. Motley

THE Canadian Pacific Railway crosses the St. Lawrence River at a point about seven miles from Montreal, near the Indian village of Caughnawaga, P.Q. This crossing is on the best of several trial lines which were located and estimated on, in the years 1883-1885. Amongst the more important were the Nuns' Island line and the Heron Island line, besides the Caughnawaga line which was eventually chosen. These trial lines are located between the Grand Trunk Railway Victoria Bridge and Lachine, the object in all cases being to obtain an outlet from Montreal towards the east and south with the least possible expenditure when the crossing of the river, as well as mileage, were taken into account. The Victoria Bridge is approximately 2½ miles long, and the engineers sought, if possible, to obtain a considerably less expensive crossing.

The Nuns' Island line gave a long crossing of the river in comparatively deep water. The Heron Island line gave a shorter bridge, located for the most part in shallow but very swift water composing the Lachine Rapids. In both these crossings the question of navigation had to be considered and difficulties connected with it weighed considerably in the discussions. The Caughnawaga crossing was finally adopted as being the most economical and as suiting best the requirements of navigation. The bridge is approximately five-eighths of a mile long, and navigation was taken care of by using two through spans of 408 feet each over the deepest portion of the river to allow for waterway, and a headway of 60 feet above high water. This avoided the use of a swing or other movable span which, in this part of the swift flowing St. Lawrence River, would constitute a serious menace to navigation. The span lengths in the balance of the bridge were generally 270 feet and 240 feet, and were dictated by the judgment of the engineers with respect to ice flow in the river.

The decision as to the crossing having been made, the substructure of the bridge was begun, with the late Mr. P. A. Peterson, M. Can. Soc. C. E., as chief engineer in the spring of 1885, and the erection of the steelwork was carried out during the winter of 1886-7. The contractors for the substructure were Messrs. R. G. Reid & Company (the late Sir Robert Reid), and the engineer-in-charge for the company was the late Mr. G. H. Massy, M. Can. Soc. C. E. The steelwork was designed by the late Mr. C. Shaler Smith and the Dominion Bridge Company were given the contract for its manufacture and erection. The steel was especially designed with a view to quick and simple erection, as it was impossible to place falsework in the deeper portions of the river where the 408 foot spans are located. For these reasons the designers decided upon a peculiar type of construction. This consisted of a set of 4 spans (2 deck and 2 through) continuous over five supports, which enabled the steelwork of the side or flanking spans to be erected first on falsework, and the main channel spans to be erected by the cantilever method, the flanking spans being used as anchors,—some steelwork was also cantilevered both ways from pier No. 13 located in the centre of the channel. When these several spans were connected, they formed, as aforesaid, a continuous span over five supports, fixed at the centre on pier No. 13 and expanding both ways therefrom. The channel spans, as noted above, were made of through design to allow steamers to pass under at full speed, and Mr. Shaler Smith solved the problem of combining deck and through spans by a very beautiful and interesting method, that of curving the ends of the spans, as shown in the photographs and plans. This procedure is open to criticism from a mathematical point of view, but, considering that the pier supports were founded on rock and, in addition, had adjusting screws, so that the ideal conditions upon which the calculations had been made, could be at all times maintained (if necessary), the design was considered justifiable. The engines, for which the old structure was designed, were equal approximately to Cooper's E35 loading, followed by a trainload of 2,500 lbs. per lineal foot, and the material in the structure was steel, except stringers, counters and windbracing where it was iron. The design lent itself admirably to rapid erection, which was borne out by the fact that the steel took only twelve months to erect ready for traffic. By 1910, the requirements of traffic had necessitated the use of much heavier engines than were considered in the original design and, in addition, the increasing volume of traffic made it advisable to double track the line from Montreal eastwards. Bids were, accordingly, called for on designs prepared by the railway company's engineers, and a contract was subsequently entered into with the Dominion Bridge Company for the removal of the old spans and the erection of the new. A contract was also made with The Foundation Company for the extension of the substructure to accommodate the extra steelwork. In the old structure there was no traffic to be taken care of, but in the new it was not allowable to interfere with the regularity of passing trains. This considerably complicated the problem, and, under the circumstances, it was decided that the only possible way of ensuring all the requirements was to build two independent single track bridges, and remove the old bridge in sections, transferring traffic from side to side, as will be described later.

Substructure

From observations during the life of the old bridge, it was noted that the ice of Lake St. Louis generally grounded on the Lachine side of the river in shallow water, and, after breaking up, floated under the Lachine end of the bridge in small pieces in a manner which did not seem to justify the existence of 4-240 foot spans between piers Nos. 3 and 7. It was, therefore, decided to bisect these spans by the building of new intermediate piers (Nos. 3a, 4a, 5a and 6a), and using 8-120 foot spans instead of 4-240 foot. This resulted in considerable economy in cost. Between piers Nos. 7 and 11, it was not considered advisable to make a change. With these exceptions, the structure

---

*Abstract of paper prepared for the Canadian Society of Civil Engineers.

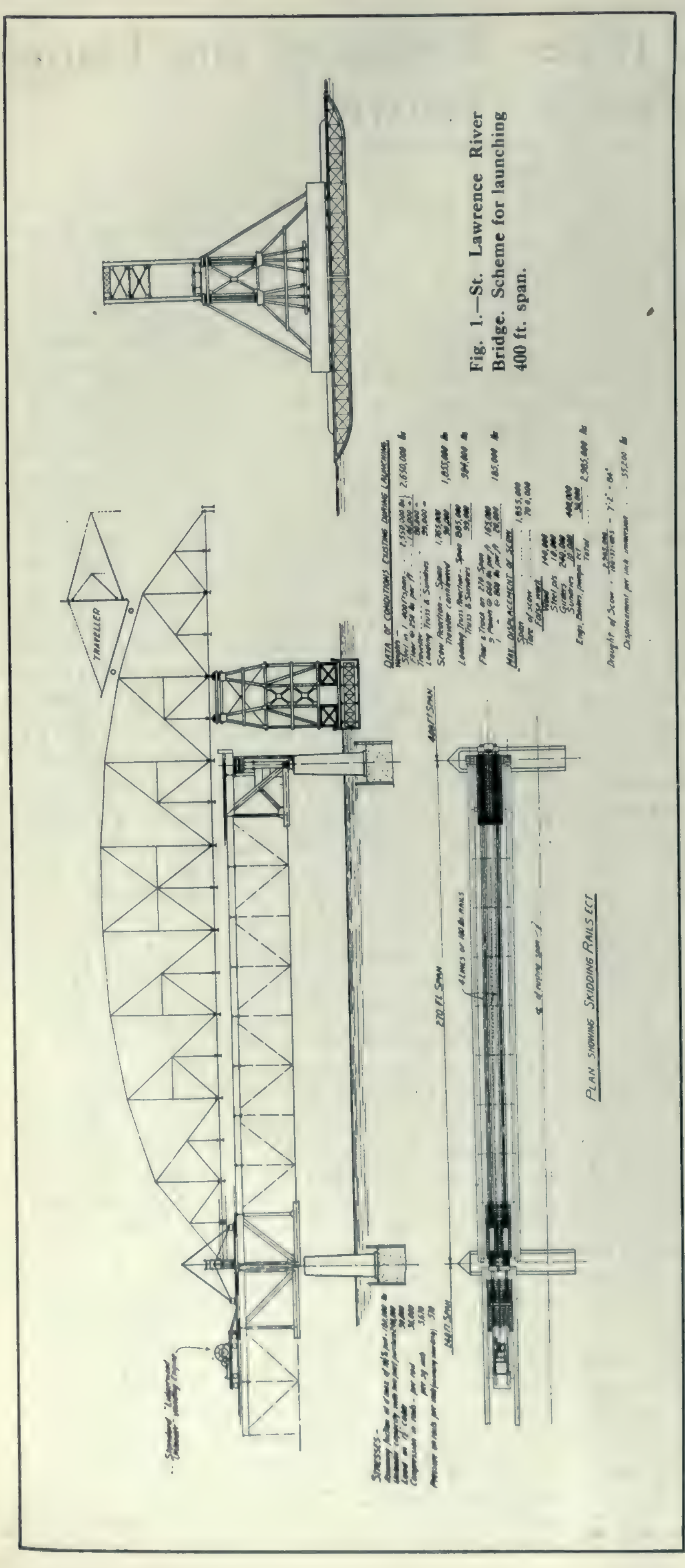

TRAVELLER
400 FT SPAN
270 FT SPAN
240 FT SPAN
PLAN SHOWING SKIDDING RAILS ECT
DATA OF CONDITIONS EXISTING DURING LAUNCHING
MAX. DISPLACEMENT OF SCOW
STRESSES

Fig. 1.—St. Lawrence River Bridge. Scheme for launching 400 ft. span.

was renewed in span lengths similar to those which originally existed, but, instead of the continuous spans between piers Nos. 11 and 15, it was decided to use simple spans of ordinary deck and through types, as shown on the plates. The new second track was placed on the downstream side of the existing bridge. The added masonry was bonded into the old above water line, while below the water line open caissons were sunk generally to the same hard bottom to which the original masonry was carried, except in the case of piers Nos. 9 to 13, where pneumatic caissons were found necessary. Caisson No. 13 was square ended where it butted against the old masonry, and pointed at the downstream end. It was carried about 7 feet lower than the bottom of the old pier, because it was found that the shale immediately under the same was of such a description as to make it advisable to go deeper in order to make sure that there would be absolutely no settlement, which, of course, would result in serious cracks in the bonding above the water line. The work at piers Nos. 8 to 14 was carried out in still water, which was obtained by the use of wing dams composed of rock-filled cribs sunk immediately upstream at an angle of about 45 degrees so as to deflect the current. Masonry was started in June, 1910, and was finished in November, 1911, except the upstream end of pier No. 13 which was left till the removal of the old steelwork, after which it was built up by the railway company's forces. The pneumatic plant used on pier No. 13 was of the type designed and operated by the Foundation Company of New York

Superstructure

The 80 foot deck plate girders at the Lachine end of the bridge are the Canadian Pacific Railway standard design, and are single track spans placed alongside each other. The 120 foot spans are Deck Warren truss spans with rivetted connections, their ties resting upon the top chords. These spans are also simple single track spans laid abreast of each other. The 240 foot spans are also Warren trusses with rivetted connections, and have the usual floor system of stringers and floor beams (2 stringers per track) rivetted against the vertical posts immediately under the top chord. The upper laterals are also rivetted immediately below the top chord, and connected with the top flanges of the stringers, where they intersect with same. The 270 foot flanking spans are Warren trusses, and, while longer in the panel lengths than the 240 foot spans, are the same in general description. All the web members, except the diagonals near the centre of the span, have solid web plates down the centre of the same, and, where necessary, double lattice on the flanges. For the deck spans the Warren type of truss was found to be more economical than any other. These spans are of the subpanelled Pratt Truss type, and the top chords are curved, as far as possible, to an approximate parabola. In the web members, solid web plates have been largely used instead of lattice bars. In addition to this, the vertical posts are all of "I" sections, composed in most cases of bulb angles and web plates, and, where necessary, there are stiffeners on the webs especially of the longer vertical posts. The top and bottom chords are of very stiff cross-section, partly to allow them to be cantilevered out during erection. The 408 foot spans were also calculated for the stresses caused by the special method of cantilevering and launching, which will be described later. The portal and other subsidiary bracing is generally of a stiff design, consistent with the main trusses, to which it is attached. The 270 foot spans were also calculated for the concentrated weight of one end of the 408 foot spans, which was to be carried upon them during the process of launching.

The alignment on the bridge is ruled by the overall width of the 408 foot spans. At pier No. 11, and the south abutment, the two single track bridges are 27 feet, centre to centre, and from pier No. 11 to the north abutment the spans grow closer together till they are 16 feet 4 inches at the north abutment. This slight kink in the alignment is quite immaterial from an operating point of view, and allowed a valuable saving in masonry from pier No. 11 northwards.

Erection

One of the most important problems in the work was the maintenance of traffic during the erection of steelwork. There were on an average 10 trains between the hours of 8 a.m. and 12 noon, and sometime an average eight in the afternoon during the usual working hours. In order to carry out the work without interference with traffic, it was decided to erect first, all spans on the downstream side from the north abutment to pier No. 7. When this was done the two new 120 foot spans between piers No. 6 and No. 7 were moved bodily into the location of the old 240 foot span, and the latter moved upstream upon timber towers prepared for it. The downstream new spans between piers No. 6 and No. 7 were then erected. Traffic was now diverted over the four new spans between piers No. 6 and No. 7 by means of a cross-over laid on suitable wooden ties spanning from span to span, so that all old spans between pier No. 7 and the north abutment were thus released. These were taken down, and new spans erected.

Next, the new spans on the downstream side between piers No. 7 and No. 11 were erected.

In order to release some more upstream spans, it was simply necessary to slew over the 240 foot span between piers No. 10 and No. 11, all new spans between the north abutment and pier No. 11 now being under traffic and all old spans between these points being released. After the new spans on the upstream side between the north abutment and pier No. 10 had been erected, it was simply necessary to pull span No. 10-11 into alignment, and thereby put the traffic on all new spans between the north abutment and pier No. 11, the old spans between pier No. 11 and the south abutment being still under traffic. Then spans were erected between piers No. 10 and No. 11, No. 11 and No. 12, No. 14 and No. 15, and No. 15 and south abutment. After these were finished, the 408 foot downstream spans were erected on top of the 270 foot spans.

The modus operandi in connection with these 408 foot spans constitutes one of the most interesting features of the work. The scheme was to launch the span endwise with its rear end supported upon an ingenious truck or buggy, while the forward end was supported on a large scow of special design.

In order to avoid overstraining the adjacent 270 foot span by the concentrated loads of the sliding gear, an ingenious framed structure was devised by which it was possible to so distribute the end reaction over the floor system of the carrying span, that no part would be strained over allowable units. A diagram of this truck or buggy is shown on Plate No. 4, from which it will be noted that the secret of the construction lies in the fact that there is no vertical tie inside the triangulation but, in its place there is an exterior strut, which by reason of the proportions of the members, carries a reaction which is equal to the reaction at each of the outer ends of the triangulation. Thus, there is a three point bearing with equal reactions. The skidways consisted of eight 100-lb. greased rails (2 sets of 4), on which cast steel skids or slippers were imposed. The scheme was to move the span forward until it came to the last panel of the 270-foot span, where, of course, the front bearing of the three would naturally tend to pass overboard. In order to satisfy all conditions, the two outer bearings were here abandoned, and the span wedged up on the centre bearing only. The whole reaction being thus concentrated on one point required required the end panel of stringers in the 270-foot spans to be reinforced. Details of this floating operation will be referred to later. The 120-foot spans were erected by means of a temporary span. The 240-foot spans were erected by the same 120-foot temporary trusses supported upon a wooden pier in the centre, as shown, between piers No. 7 and No. 8, and in the photographs.

The 270-foot spans were erected by these same 120-foot temporary trusses supported on a temporary tower about 30 feet wide, the only falsework at any time in the river being the towers as shown, and at no time was railway traffic placed upon the temporary falsework. This was required by the Railway Company from the beginning of the work.

The four 408-foot spans were alike in weight and general characteristics but, two methods differing somewhat in detail, were used in launching them. The two downstream spans were launched on the same set of carrying scows, but with a pilot scow upstream to take up the slack in the cables and to otherwise control the movement of the spans during launching. The experience gained in launching the two downstream 408-foot spans led to the abandonment of the pilot scow for the placing of the upstream spans. Under this arrangement the new spans were allowed, while travelling, to rub along a specially prepared vertical skidway bolted to the lower chords of the downstream spans already in place.

The carrying scow was really composed of two independent scows with two 100-foot deck plate girder spans (4 girders) placed on them, to equalize the load over the two scows. On these equalizing girder spans were erected a stiff timber tower on which the span itself was carried.

Anchors, each composed of concrete blocks securely strung together, weighing approximately 76 tons out of water or 52 under water, were placed about 1,500 feet upstream from the bridge, and generally respectively in line with piers No. 12 and No. 13, but on the land above pier No. 14 a "dead man" was used

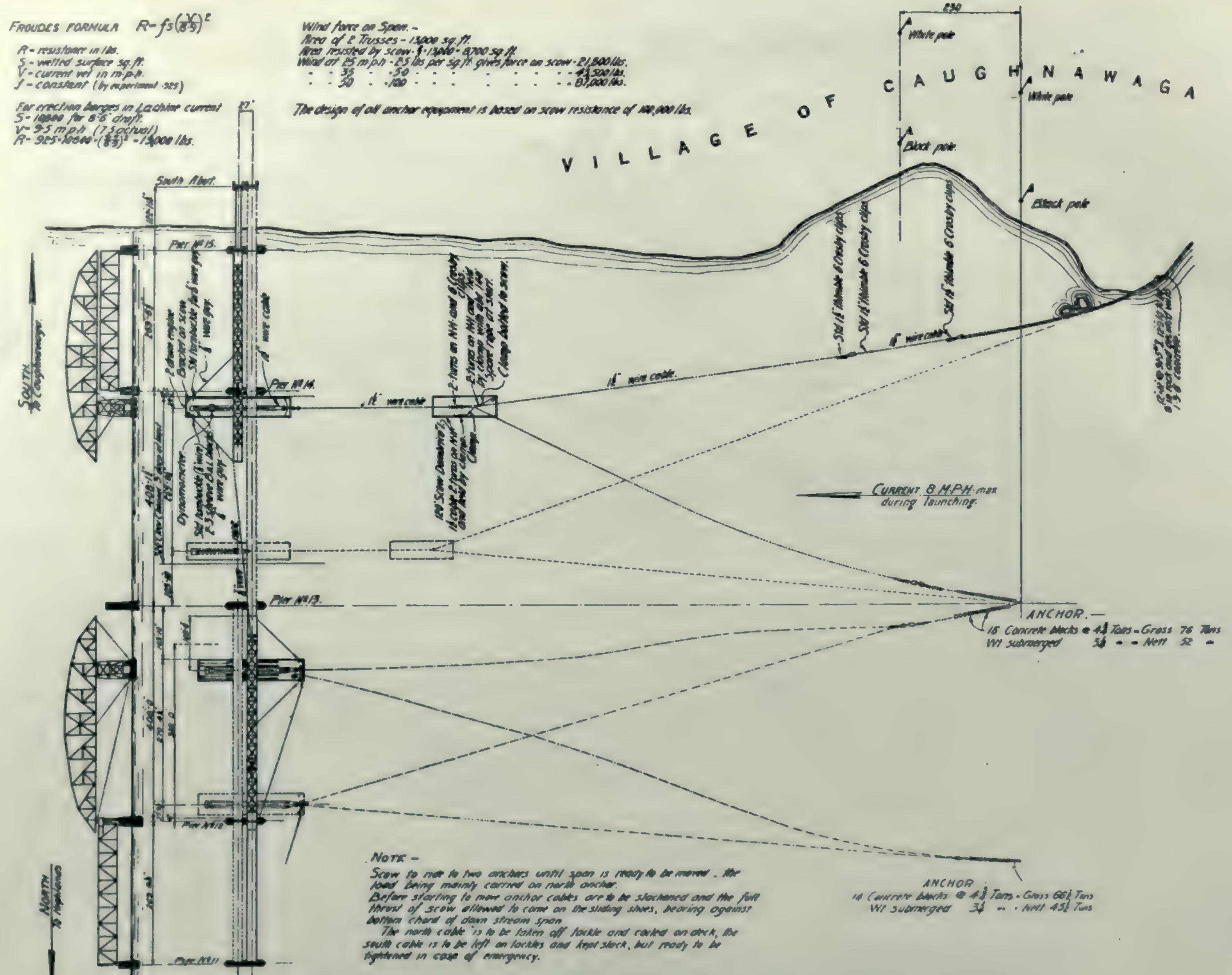

FROUDES FORMULA R-fs(V/8.5)²
R - resistance in lbs.
S - wetted surface sq. ft.
V - current vel in m.p.h.
f - constant (by experiment .925)
For erection barges in Lachine current
S - 10800 for 8'6" draft.
V - 9.5 m.p.h. (7.5 actual)
R - 925 · 10800 · (9.5/8.5)² - 15,000 lbs.
Wind force on Span.-
Area of 2 Trusses - 13,000 sq. ft.
Area resisted by scow - ⅔ · 13,000 - 8700 sq. ft.
Wind at 25 m.p.h. - 2.5 lbs per sq. ft. gives force on scow - 21,800 lbs.
" " 35 " " 5.0 " " " " " " 43,500 lbs.
" " 50 " " 10.0 " " " " " " 87,000 lbs.
The design of all anchor equipment is based on scow resistance of 100,000 lbs.
VILLAGE OF CAUGHNAWAGA
White pole
White pole
Black pole
Black pole
230
South Abut.
Pier Nº 15.
Pier Nº 14.
Pier Nº 13.
Pier Nº 12.
Pier Nº 11
SOUTH
to Caughnawaga.
NORTH
to Highlands
1½" wire cable
1½" wire cable.
1⅛" wire cable
1⅛" wire cable
Dynamometer.
CURRENT 8 M.P.H. max
during launching.
ANCHOR.—
16 Concrete blocks @ 4¾ Tons = Gross 76 Tons
Wt submerged 3¼ " " Nett 52 "
ANCHOR
14 Concrete blocks @ 4¾ Tons · Gross 66½ Tons
Wt submerged 3¼ " · Nett 45½ Tons
NOTE -
Scow to ride to two anchors until span is ready to be moved. The load being mainly carried on north anchor.
Before starting to move anchor cables are to be slackened and the full thrust of scow allowed to come on the sliding shoes, bearing against bottom chord of down stream span.
The north cable is to be taken off tackle and coiled on deck, the south cable is to be left on tackles and kept slack, but ready to be tightened in case of emergency.
400'-0"
400'-0"

Fig. 2.—St. Lawrence River Bridge. Location of anchors, scows, etc.

composed of an "I" beam embedded in the rock. On the main carrying scow a dynamometer was inserted in the reaving of a fourteen roped tackle which was attached to the main anchor line, in order to record the pull on the anchor ropes. The readings taken from this dynamometer fully corroborated experiments which had previously been made regarding the resistance of floating bodies to the current in the river. They also agreed generally with Froude's formula $R = fs\left\{\frac{v}{6.9}\right\}$, see Fig. 2. The current in the river varied between 5 and 8 miles an hour, according to the location where the meter was used.

Details of Launching Operations

When all was ready, an ordinary Lidgerwood unloader, such as is used on railway work, was located and strutted in a position where a direct pull could be made from the drum of the engine. Communication was at all times maintained between the man in charge of the Lidgerwood engine, those in charge on the scows and the man in full charge of the operations, by means of a system of flag signals. The span was started by a number of jacks, after which the Lidgerwood engine controlled the whole of the movement and at no time was there any unexpected trouble. While the span moved forward the anchor cables allowed the anchor scow to float across the current with a radial motion. This necessitated the cable connecting the anchor scow with the main scows to be constantly shortened in order to maintain the true alignment of the span. As has already been stated, these anchor scows were used only in connection with the floating of the two downstream 408-foot spans. They were omitted when floating the upstream 408-foot spans, which were allowed to rub against the neighbouring spans already in position. The adjustment of the anchor cables was made as required.

The time occupied in the floating operations is extremely interesting:—

Span	Between piers Nos.	Date floated into position	Elapsed time h.—m.	Net time occupied in moving h.—m.	Total distance floated
Downstream 408 feet...	13 and 14	Nov. 4/12	3—0	1—0	275 ft.
Downstream 408 feet...	12 and 13	Nov. 22/12	2—30	28½	275 ft.
Upstream 408 feet...	12 and 13	Sept. 18/13	1—30	22½	275 ft.
Upstream 408 feet...	13 and 14	Oct. 6/13	2—0	16	275 ft.

Total weight of each 408-foot span while launching was 1,300 tons.

During each of these operations, all the regular trains of the railway company were allowed to pass on the adjoining spans, which necessitated stopping the floating operations because the work of signalling and superintendence, were interfered with. The difference between the net time and the gross, was occupied in overhauling cables, taking up slack, and in dismantling some of the steelwork connected with the special truck or buggy when it reached the last panel of the 270-foot span. At this point, it was necessary to remove certain steelwork which became no longer necessary on account of the load being shifted, from a 3 point to a 1 point bearing. A diagram of this buggy is shown in Fig. 1. The perfection of the control under which the span was at all times, is exemplified by an incident which occurred during one of the floating operations. The span had reached a point 3-in. short of its correct location, and after the necessary signalling over the intervening distance of nearly 800 feet the Lidgerwood engine driver made exactly the 3-in. movement called for, no more and no less. This is remarkable considering the tonnage being handled. As has already been stated, the 408-foot spans were skidded upon the deck of the adjacent 270-foot deck spans, and after each pair of the large spans (on one track) were floated into correct location they were at an elevation approximately 12 feet higher than their permanent levels. This required that they be jacked down to their correct bridge seat levels, which was done by means of 150-ton jacks and blocking, the end floor beams having been designed for this purpose as were also the end cross beams of the 270-ton spans. The 240-foot spans were also provided with special end bracing to enable them to be jacked up on the piers, if necessary, during erection.

The time occupied in erecting the steel is as follows:—

March, 1911........	Erection started at north end.
May 28th, 1911.....	New 120-foot spans moved into upstream alignment replacing old 240-foot span between pier No. 6 and No. 7.
July 6th, 1911.......	Traffic diverted to downstream track between piers No. 6 and No. 7.
Nov. 12th, 1911.....	New downstream span between piers No. 10 and No. 11 slewed over, thereby releasing old spans between piers No. 7 and No. 11.
March 31st, 1912....	Spans Nos. 10-11 moved into upstream alignment allowing erection to proceed on downstream spans Nos. 10-11.
June 18th, 1912.....	Spans Nos. 14-15, and 15-south abutment erected.
July 13th, 1912......	Downstream spans Nos. 10-11 and Nos. 11-12 erected.
Nov. 4th, 1912......	Downstream 408-foot span Nos. 13-14 floated.
Nov. 22nd, 1912.....	Downstream 408-foot span Nos. 12-13 floated.
April, 1913.........	Started taking down old spans between pier No. 11 and south abutment.
June 10th, 1913......	All old steel dismantled.
Sept. 18th, 1913.....	Upstream 408-ft. span Nos. 12-13 floated.
Oct. 6th, 1913.......	Upstream 408-ft. span Nos. 13-14 floated.
Nov. 4th, 1913......	All new steel erected and double track put into service.

The total weight of metal work in the old bridge was about 4,100 tons, in the new it was 14,231 tons.

The total quantity of masonry and concrete in the original piers and abutments was approximately 12,400 cubic yards.

In the additions to old piers and in new piers there were 13,300 cubic yards.

The total length of the bridge and height above watermarks were not changed, and are indicated on the plates.

The number of rivets in the new bridge is approximately 3,500,000.

As far as can be ascertained from the records, about 3,500 cars were used in transporting stone and steel to the bridge. These cars would, if placed in a single train, extend over a distance of 21 miles.

One of the noteworthy performances during erection was the speed with which the five old spans between pier No. 11 and the south abutment were dismantled and the new spans erected. This was done between the dates of April 22nd and October 31st, 1913. That is to say, 4,000 tons of steel were handled in six months, or, 666 tons per month, and this without interrupting the railway company's traffic.

During the work, one man was drowned from one of the scows engaged on the substructure and one man was killed in Highlands Station Yard; but, during the erection of the steelwork over the river proper, there were no fatalities, and one a few minor injuries to men.

The cost of the work was slightly under $2,000,000.

In charge for the Foundation Company were Mr. John W. Doty as Chief Engineer, with Mr. W. B. Taylor as Superintendent on the work.

For the Dominion Bridge Company, Mr. G. H. Duggan was Chief Engineer, and Mr. F. P. Shearwood, Mr. James Finley and Mr. David Bell were in charge of the design, superintendence and erection respectively.

For the Railway Company, Mr. J. M. R. Fairbairn was Assistant Chief Engineer, Mr. C. C. Schneider was connected with the work as Consulting Engineer, and for the design and approval of all detail plans the writer was responsible, as Engineer of Bridges for the Railway Company.

This record of the rebuilding of this work should not be concluded without referring to the place it occupies among the world's more important bridges. At the time of the erection of the first bridge, recently removed, the work was considered a remarkable example of the creative skill of the engineer. To-day the old structure, in view of the experience of the last twenty years, would be considered an achievement of only average rank. The new structure is no world's wonder as far as design and details are concerned, but, in view of the fact that there are recorded only a few instances, probably not more than eight, where large spans have been erected by the end-launching method, it is worthy of note that the work just completed includes the erection of no less than four large spans by this method, in what may be regarded as record time, and without a mishap of any kind. This is an accomplishment, of which the members of this Society need not be ashamed, and which further goes to show that, while our great profession knows no national bounds, it is not necessary to go outside this country to find men fully qualified to harness the great forces which exist in nature for the use and convenience of man.

A rather uncommon sign has recently been built into a new concrete structure used as a garage at Clinton, Wis., the name of the motor company being cast in bold relief in the face of the building. Forms constructed on the ground with the letters reversed were lifted into place and the concrete poured during the construction of the masonry wall. There is no question as to the stability of the sign and it harmonizes in material and color with the lintels, sills and ornamental trim.

Reinforced concrete is in practically universal use in the Philippines for all new construction under government control. School buildings are designed in units to which additions are made as growth demands but are uniformly of concrete for floors, walls and foundations. The peculiarity of the typical building is that it stands on stilts, or rather piers of concrete which permit a free circulation of air beneath the building in order to carry away moisture. The government administration buildings are of similar construction except that in some of them stone columns are used.

Failure of Concrete Buildings

THE failure of concrete buildings is due to dishonest workmanship, and not so frequently to mistakes in design, according to Prof. Ira H. Woolson, consulting engineer of the National Board of Fire Underwriters, in his remarks before the Round Table Order of the Insurance Society.

Prof. Woolson referred to the two general types—one the reinforced concrete building, and the other the steel skeleton structure building with reinforced concrete used for the floors, etc. He said the Bush Terminal building and the Gair building in Brooklyn are samples of the reinforced concrete type, while many other large buildings in New York City are of the fire resistant steel skeleton structure type in which concrete is used largely. The best features of concrete construction are that such buildings are both fire resistant and water resistant. They are strong and rigid and can be constructed at a moderate cost. No kind of construction gives greater rigidity at the same cost as reinforced concrete.

Prof. Woolson told how about 80 tests had been made principally in the East of concrete construction, and he had been present at half of them. The first fire test was made in September, 1896, and the material was tested for six hours. At the present time the standard test is four hours, with an average temperature of 1,700 degrees Fahrenheit. These tests prevail in Chicago, Philadelphia, New York and other cities.

Fire tests of columns had been very difficult heretofore, and small columns, viz., 8 or 9 inches diameter, had furnished the principal tests. The Underwriters' Laboratories in Chicago is building a huge furnace at a cost of about $15,000, which will permit the adequate testing of concrete columns and with the idea of determining the load which they can carry.

Prof. Woolson discussed the necessity for proper mixing of concrete in order to get the best results. The concrete should be made rich and dense, and plenty of cement should be used. There are a few notable cases where, perhaps, the collapse of concrete buildings was caused from defective design.

Owing to the fact that concrete does not show its weakness after it is once hardened, he said, it is necessary that the various stages be carefully inspected; as dishonest work and the use of inferior materials not up to the specifications have been found to be the cause of most of the failures of concrete buildings.

The careless placing of steel reinforcement in floor slabs or in beams weakened concrete construction. He said he could not lay too much emphasis that good and intelligent workmanship is necessary to make concrete right. As soon as the builder attempts to economize in his materials trouble will begin.

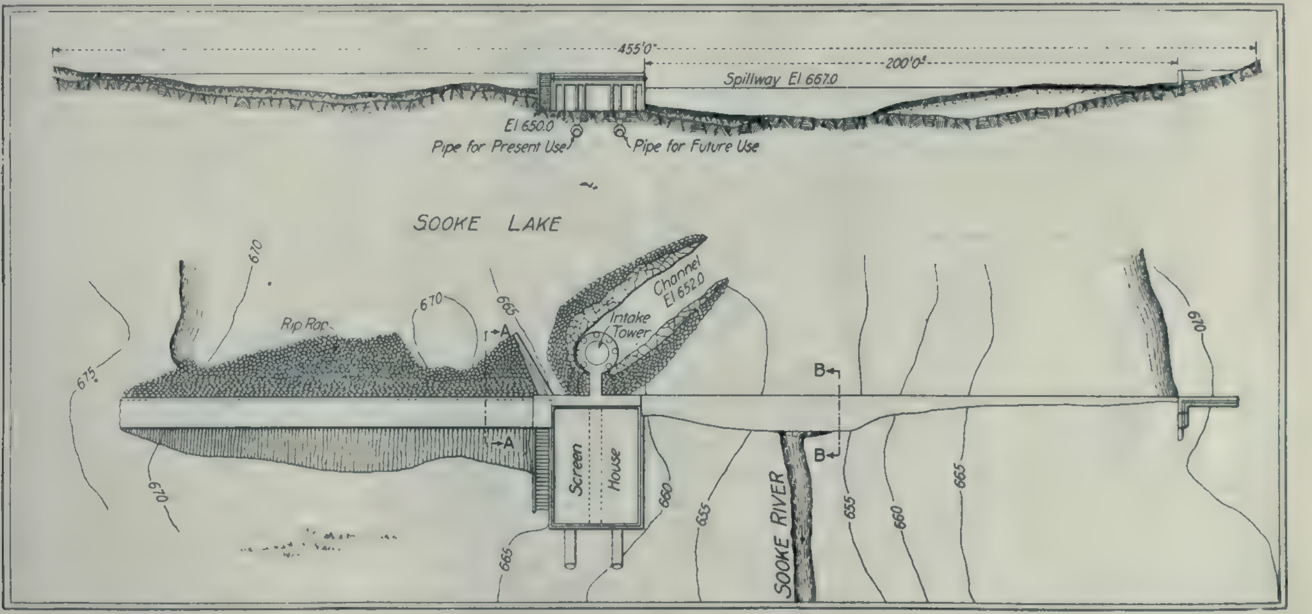
The danger of prematurely removing the wooden molds was also emphasized. Prof. Woolson said there is no definite rule for the time for removing the forms, but the setting of the concrete and experience alone will determine this. Frozen concrete frequently collapses when the ice in it melts, and this disintegrates the material. The overloading of new concrete is a particular detriment. Frequently before the floor arches are properly set the building contractors dump heavy loads of building material upon the newly made floor. This tends to weaken the structure.

Concrete is often ruined, he said, because a poor grade of sand is used, while frequently a poor grade of cement, or not enough of it, likewise causes collapse.—Concrete Age.

Lay-Out of New Water Supply System for the City of Victoria, B.C.

VICTORIA, the capital city of British Columbia, situated on the south end of Vancouver Island, had its first water system installed in 1868, when a private company pumped from wells and delivered through wooden pipes, making a charge of 0.75 cent per gallon. In 1872 Elk Lake was first studied as a possible source of supply and was rated as capable of furnishing 25 gal. per capita per day for a population of 90,000. As later constructed by the city, the Elk Lake supply, after passing through open gravity sand filters, was delivered to the city in low and high-pressure zones by a gravity system.

The necessity for increased supply and for greater fire pressure led to the installation of a pumping plant in this system, and when the daily consumption reached about 2,000,000 gal. the lake level was lowered thereby and the quality of the water impaired. At this time Victoria West was supplied by water purchased from the Esquimalt Waterworks Company, a private corporation which owned rights on the Goldstream Lakes.



Plan and section of Sooke Lake Dam, showing intake channel and pipe connection from screen house.

Water Rates

About 5,000,000 Imp. gal. were supplied to the city of Victoria in the dry months of 1913, the maximum daily rate per capita during these months being about 80 gal. The water taken from Elk Lake costs the city about 2 cents per 1,000 Imp. gal., while the price of water from the Esquimalt Waterworks Company is fixed by charter at 6 cents per 1,000 Imp. gal. The latter rate was considered excessive, as was also the price which the company asked for its holdings, and in June, 1912, after the proposition of an additional water supply had been under consideration for several years, it was decided to construct a supply system from Sooke Lake to the city.

The most practicable scheme among the various projects considered seemed to be to reservoir Sooke Lake for a 12-ft. lift of water level and lay a 40-in. concrete pipe on a slope of 1 in 1,000 to an artificial lake known as Humpback reservoir and located about 10 miles outside the city. The pipe is to be laid on the surface and the route traversed between the two reservoirs is 27.3 miles long. From Humpback reservoir a 36-in. steel pressure main will lead to the Smiths Hill service reservoir, which is located in the city at an elevation of 213 ft. above sea level and has a capacity of 16,000,000 Imp. gal.

Preliminary and Location Surveys

On July 1, 1911, when the city decided to take up active work on the extension of its water supply, there were no hydrographic data or maps in sufficient detail to decide any of the engineering questions at issue. Gaging stations for rainfall and rated sections on the Sooke and Leech Rivers were established at once, while engineering parties proceeded with a contour survey of Sooke Lake, running traverses of the various pipe lines that had been under consideration and determining the areas of the Sooke Lake and Leech River watersheds. These surveys were through thick forests of Douglas fir and over very rough country. Often precipitous rocky bluffs, difficult of access for work or for the transportation of supplies and equipment, delayed the progress, and since the work extended into the winter, working conditions were very trying. The time at which it was proposed to submit the project to popular vote necessitated expeditious work in order to get even the preliminary surveys in shape for the general plans and specifications. This was accomplished, however, and tenders of contractors were received December 15, 1911.

In the work of adjusting a gravity grade location for the concrete pipe the same difficulties of dense forests, rocky bluffs and a winter season had to be contended with. Surveys and locations closely followed the methods used in railroad work. No angles of more than 3 deg. were used at the joints, and concrete pipe was assumed to be in 4-ft. lengths, while the steel pipe was considered as being in 22-ft. lengths. The roadbed for the concrete pipe, which was generally in side-hill work, was staked for an 8-ft. width. Tile pipe was laid for drainage openings, steel bridges were designed for the siphon crossings, and reinforced concrete trestles for the wide drainage openings and approaches to the bridges.

Sooke Lake

Sooke Lake lies to the northwest of Victoria, about 18 miles distant as the crow flies. It is about 4 miles in length and ½ mile wide at its maximum width. Two narrows divide it into practically three lakes, of which the upper and largest has a maximum depth of 150 ft. Its main feeders are Ferguson Creek on the east side and a very large spring directly opposite on the west shore, which supply a total of about 3 sec.-ft. in the driest seasons of the year. The area of the lake at low water, which is 555 ft. above sea level, is 964 acres, and the total watershed area is 31.33 sq. miles. This watershed, rising in places to more than 2,500 ft. in elevation, is densely wooded with Douglas fir, and except for the narrow flat around the lake shore has a steep slope of precipitous bluffs of trap rock. It is bounded on the east by the Leech River watershed, 30.33 sq. miles in area, and joins the watershed of the Esquimalt lakes on the south.

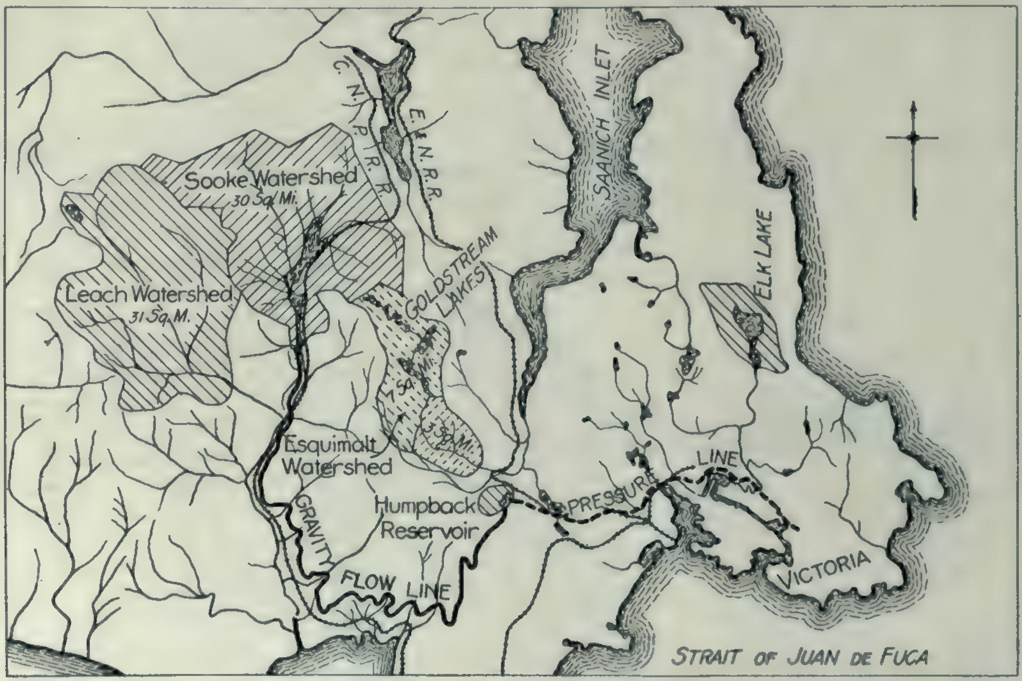
In the scheme for the ultimate development it is proposed to utilize the Leech River water supply by building a diverting dam in the stream and a 5-mile conduit to convey water to Sooke Lake. When this is done a dam rising to a height of 45 ft. above the present low-water level of the lake is projected, and it is estimated that a daily flow of 100 sec.-ft. will be available, while the reservoir storage above low-water level will be 17,358,000,000 Imp. gal. The initial project now under way, by the use of a concrete dam at the outlet, will raise the lake 12 ft., and this will give a reservoir capacity, above low-water level, of 3,355,000,000 Imp. gal.

The provision that the margin of Sooke Lake should be cleared to 15 ft. above low water affected 300 acres of thick forest, which had to be cut down and burned. About 2 miles of wagon road along the lake shore had to be built at this high-level elevation, and it was provided that the Canadian Northern Railway should build its proposed line at an elevation 50 ft. above low water, to admit of the ultimate project to reservoir the waters of the Sooke and Leech River watersheds to a height of 45 ft. above low water.

Intake and Dam

At the dam the intake channel is excavated 4 ft. below low water, and there will be an intake tower controlled by seven sluice gates, three 30 x 42 in. and four 24 x 30 in. The gate openings will be protected by bar screen cages anchored in the concrete. From the intake tower two 40-in. riveted steel pipes will be laid to conduit the water to the screen house, but only one of these will be put in service at present. In the screen house will be installed a set of twelve screens with a mesh of 40 openings to the inch. Below these are the measuring weir and cascade steps to the conduit pipe at a grade elevation 12 ft. below the low-water level of the lake. The screen house will be of concrete with a concrete roof and windows protected by wrought-iron grillages. A sink will be provided with water under pressure from a 6,000-gal. tank for washing the screens.

The dam will be a composite structure, the west end being an earth embankment, with a concrete core wall bonded into the natural rock. Then comes a reservoir section wall with a screen house at its back. From the screen house to the east abutment an ogee weir section 200 ft. long will be used, which is generally about 15 ft. above the foundation of natural rock. This will be bonded into the rock with a cut-off trench at the upstream face. About 2,200 bbl. of cement will be used at the site, which will have to be hauled 9



Map of watersheds, reservoirs and pipe lines for Sooke Lake supply.

miles from Fitzgerald's station on the Esquimalt & Nanaimo Railroad.

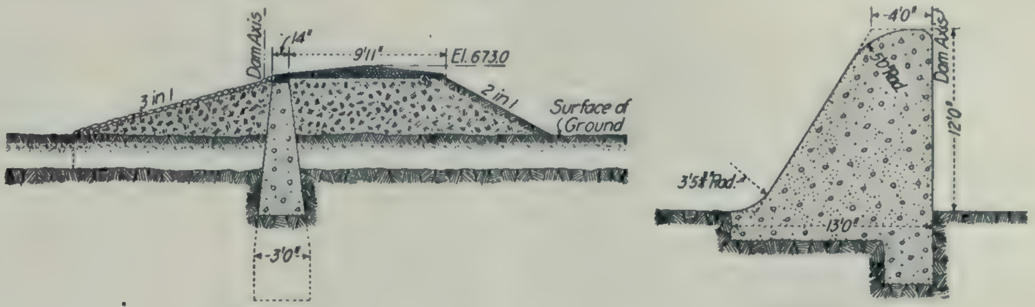
Concrete Pipe Line

A consideration of the three alternative bids on wood-stave, riveted-steel and reinforced-concrete pipe resulted in favor of the last-named type, largely on account of its permanency and economy. The initial development is being carried out with a single pipe line, 40 in. in diameter, which is to give a daily supply of approximately 16,000,000 Imp. gal., this being calculated as sufficient for at least 200,000 people at Victoria's present rate of consumption. The flow in the pipe was estimated for C = 120 in the Chezy formula, or n = .012 (about) in Kutter's formula.

The reinforced-concrete pipe is designed with a 40-in. inside diameter and a 3-in. thickness of walls. The reinforcement will be wire mesh with an area of 0.043 sq. in. per foot of pipe and a 0.025 sq. in. sectional area of cross wires per foot. The pipe, which will be built up along the line in 4-ft. lengths, is to be of the type patented by the Lock Joint Pipe Company, of New York.

As no materials suitable for making concrete occur along the grade, it will be necessary to establish a pipe yard where these can be made. The finished pipe will then be hauled up an incline railway to the grade and conveyed to the desired point by the construction railway on the conduit roadbed, which will also be used in the erection of the various drainage structures. The pipe will be leveled to grade and supported upon crushed-stone ballast.

A right-of-way 100 ft. wide was secured for the pipe line, and all trees in this strip were cut down, as were also all high trees outside this strip which might reach the pipe in falling. It is not proposed to cover the pipe except in the deep cuts where slides might occur. At each 2,000 ft. point on the conduit line there will be an open standpipe, and all inverted siphons will have waste outlets at the bottoms controlled by 6-in. gate valves. All inverted siphons are to have steel reinforcement, varying in quantity according to the head. Anchorages and expansion joints are specified where necessary.



Section A-A

Section B-B

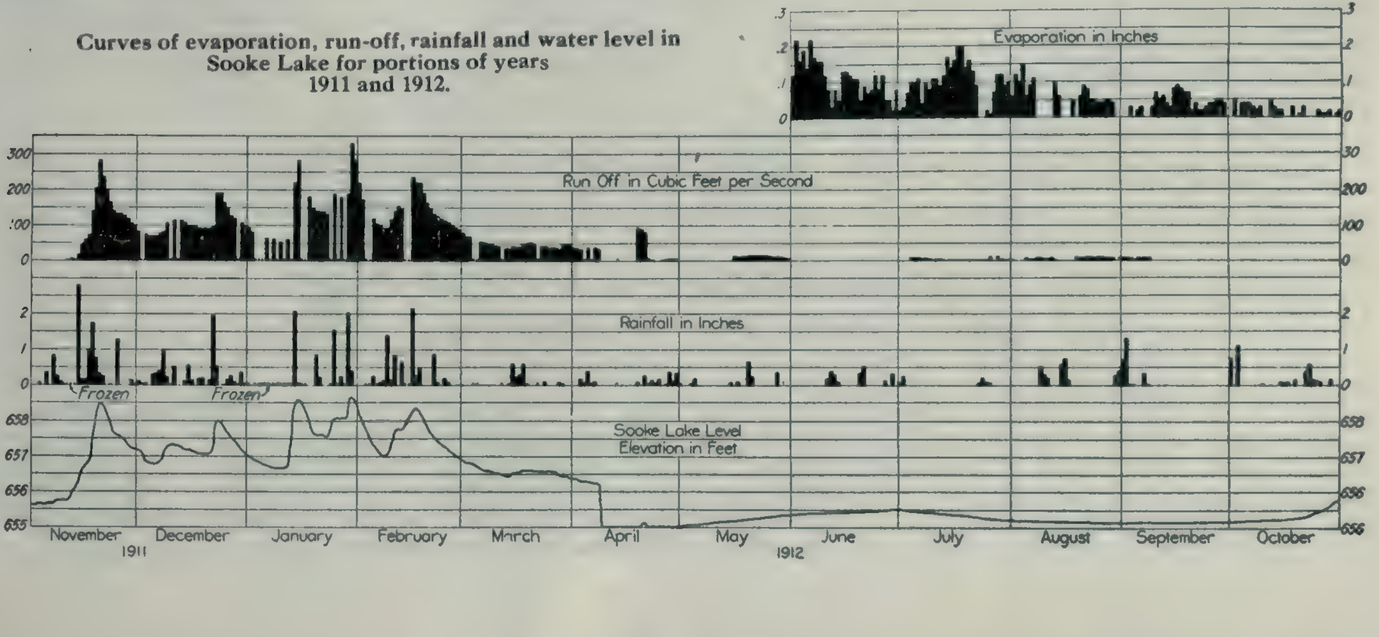
Earthfill and concrete ogee sections of dam.

Drainage Openings

The drainage openings along the flow-line grade are of several varieties. For the smallest drainage the water will be carried along and passed under the pipe line by small holes through the ballast at points where the roadbed is in the rock. For a somewhat larger volume of water concrete side walls will support the pipe where the span requires it, and if the crossing is at a point where earthy material occurs it will be protected from scour by concrete. This refers to the shallow openings practically at grade; but where there is some embankment, vitrified pipe from 12 in. to 24 in. in diameter will be used; for a still larger volume, open ravine culverts of 15 ft. span with a concrete girder and saddles will support the pipe, while 45 to 80 ft. steel bridge spans with concrete abutments will be used to cross streams at low points of the siphons. Six siphons are required, and these will be laid to precise horizontal and vertical curves. The deepest siphon is 600 ft. long and has a maximum head of 90 ft.

One of the difficulties in connection with the project was to secure a reserve reservoir at the proper elevation and near the city. A suitable site was finally located on the Humpback Road, about 10¾ miles from

Curves of evaporation, run-off, rainfall and water level in Sooke Lake for portions of years 1911 and 1912.



Fountain Square in Victoria. This reservoir covers an area of about 40 acres, from which it was first necessary to clear a thick forest. The earth on the reservoir site is a black soil of a peaty nature, and it is proposed to cover this with a 6-in. layer of clean sand and gravel, to act as a diaphragm between the soil and the stored water.

Test pits were excavated on the site proposed for the dam and satisfactory rock foundation found. In the deepest part this was about 30 ft. below the valley floor. A concrete dam was planned here and is so located that with a maximum height of 60 ft. and a crest length of 600 ft. it impounds 136,000,000 Imp. gal. The dam contains about 8,000 cu. yd. of masonry.

A gate house with control valves and screens was provided at the dam and two cast-iron outlet pipes 34 in. in diameter were installed for delivery to the pressure mains, while a 16-in. cast-iron pipe will be used to discharge waste water.

On reaching the Humpback reservoir the water from the gravity-flow line will pass over a weir into a concrete chamber, from which there will be an outlet either by flowing over a stepped cascade, over concrete and rock into the reservoir (for aeration) or by a pipe with a submerged outlet, controlled by a butterfly valve. The pipe will taper from a 36-in. diameter to a 24-in. diameter in 20 ft. and will be used if there is a tendency for the water to churn milky due to microscopic growths.

Riveted Steel Pipe

It is proposed to deliver the water from the Humpback reservoir to the city through a 36-in. riveted steel pipe. Delivery could not be made from the pipe direct to the city service system, as the pressure would be too great, so the water is allowed to overflow into Smiths Hill reservoir as a stand pipe. This is situated at the southern city limits at an elevation of 167 ft. below the water level of Humpback reservoir, or 213 ft. above sea level, while the average elevation of the city is, roughly, about 5 ft. above sea level. The elevation of Humpback reservoir will enable it to deliver later directly into the city's high-level system, which has to be served at present by pumping.

A consideration of tenders on riveted steel pipe and lock bar pipe for this pressure line resulted in a decision to use the former. There will be two thicknesses of plate—20,500 lin. ft. of pipe using plates 5-16 in. in thickness and 36,500 lin. ft. of pipe using ⅜-in. plates. This plate will be made by the open-hearth process, and the rivets are to be extra-soft steel, according to the requirements of the American Society for Testing Materials. The pipe is to be made in four-plate lengths, which will give sections about 22 ft. long. Each pipe is to be dipped in a hot bath (400 deg. Fahr.) of Pioneer mineral pipe coating, bitumastic, or their equal. Inside and outside courses are to be used. The riveting and spacing of rivets must produce a 70 per cent. joint. All rivets are to be driven by pneumatic or hydraulic-pressure machines in the shop and pneumatic hammers in the field. No angle will be permitted in any joint of the pipe line of more than 3 deg.

There are to be four concrete gate houses located along the line, with 36-in. rising-stem gate valves; 6-in. nozzles will be riveted to the pipe for the 6-in. gate valves which are placed at the bottom of all dips for emptying the pipe. Inlet and outlet air valves will be similarly attached to 4-in. nozzles on top of the pipe, the former to prevent collapse and the latter to prevent air binding at the summits. A Venturi meter with a recording apparatus will be installed in a concrete house a short distance below the Humpback dam, with which an accurate record is to be kept of the water passing through the pressure main.

A contract for the construction of the entire work was made with the Westholme Lumber Company, of Victoria, in January, 1912, but this contract was abandoned by the company in April, 1913, and since then the city has proceeded with the project both by day labor and by sub-contract. A contract for the 27.3-mile gravity-flow line was recently awarded to the Pacific Lock Joint Pipe Company, of Seattle, Wash.

Wynne Meredith, of the firm of Sanderson & Porter, of New York City and San Francisco, was retained in July, 1911, as the consulting engineer for the city's water commissioner. Boyd Ehle is the present resident engineer at Victoria. James H. Raymur, as water commissioner, was the executive of the city of Victoria in charge of the project during the preliminary stages, and was succeeded early in 1913 by Charles H. Rust.—Engineering Record.

Freezing Process for Foundations

Cases sometimes arise where ordinary foundations cannot be constructed, either owing to the presence of quicksand, or to the fear that the driving of ferro-concrete piles would be prejudicial to adjacent buildings. The reconstruction of the foundations of St. Paul's Cathedral is thought to constitute a most difficult problem because excavations might cause disastrous results and pile driving is not desirable. The difficulty, however, could readily be overcome by the aid of the freezing process, permitting the necessary excavation to be made for ferro-concrete foundations, based on solid hardpan below the potter's earth on which the existing piers are carried, and underpinning the entire structure so as to make it safe for all time. The process has recently been applied with economy and general satisfaction in Berlin, where the foundations of a large building had to be carried 10 ft. below the foundation of the adjoining structures. As the latter were built on running sand, it was entirely out of the question to excavate for the new building without special precautions, and the freezing process was adopted. Freezing pipes of 5 in. diameter were sunk around the space to be excavated and connected by headers with a brine pump and tanks. Cold brine was pumped through 1 in. pipes enclosed in the 5 in. pipes, and the brine was returned to the tanks through the latter. When the apparatus was in operation the effect was to establish a stable barrier of frozen quicksand, permitting the foundation space to be excavated without difficulty.—Ferro-Concrete.

A new type of suction-dredge mouthpiece without any rotating element has been patented in Germany by Herrn Pieter von Wienen, of Hamburg. It has the shape of a square box, as shown in the accompanying drawing. Above the lower side is a bent plate forming a dam across the opening. In line with the back slope of this plate and above it is placed the inclined intake for water, this arrangement providing an efficient means for breaking up the dirt and giving a good mix. The amount of water is regulated from the dredge by a chain operating a flap valve at the pipe intake. An adjustable shield in the front of the box, supported on three struts running in guides and held in place by screws, serves to guide the material to the opening in the mouthpiece.

Deleterious Effect of Rust in Steel Highway Bridges

By Clifford Older[*]

INVESTIGATION of steel highway bridges by the Illinois Highway Commission indicates that few of these structures are ever painted after final completion and acceptance. Steel structures located in cities or near railways, rust rapidly if not properly protected from the gases produced by the burning of bituminous coal. This is particularly the case where bridges span railway tracks.

The fact that such structures cannot be neglected without danger of serious results is illustrated by a recent investigation of a pony truss bridge carrying an important highway over a railway. The floor planks were supported by wood beams placed at right angles to the roadway and resting on the outstanding legs of the lower chord angles of the trusses. Each lower chord was composed of two 4 x 5 x ½-in. angles. The floor planks were placed diagonally. The outstanding legs of the angles for a distance of about 3 ft. over the track were entirely destroyed by corrosion and the vertical legs were materially affected. It is likely that the dangerous weakness of this bridge would not have been discovered had it not been for the fact that the arrangement of the floor supports was such that two of the wood beams were left unsupported and finally fell to the track below. This bridge had been completed but five years.

In southern Illinois a peculiar condition exists which undoubtedly has a material bearing on the corrosion of steel structures. In that portion of the state popularly known as Egypt, a large proportion of the surface soil when tested, shows a marked acid reaction. This condition exists generally throughout the greater part of the state which lies south and east of the Kaskaskia River and south of the latitude of Mattoon. To a less marked extent, the soil is acid in many places elsewhere in the state where the land has been farmed for fifty years or more.

This acid condition does not exist for a depth of more than a few inches, and steel buried at a greater depth does not seem to exhibit any unusual tendency to corrode. The greatest effect is noticeable at, or slightly above, the ground surface and at other places where dirt may become lodged. Such accumulations of dirt are constantly being washed away by the rains and are again replaced by a fresh supply of the acid soil brought by the wheels of vehicles, the wind or other agencies. Wherever this acid soil accumulates readily (as it does about the shoes, stringers, floorbeams, lower chords, and elsewhere below the floor of the bridge), corrosion is very rapid unless the steel is kept well protected by paint or is incased in concrete.

Examination of many steel structures in the district mentioned has disclosed the fact that steel plates, angles, or the webs of channels or I-beams having a thickness of ¼ in. or less, when exposed on both sides to the conditions mentioned, are completely destroyed by corrosion in from ten to twelve years. Examination of comparatively new structures seems to indicate that the initial cost of paint affords protection for two or three years. The period of active corrosion is therefore probably not longer than eight or ten years.

Corroded channels were removed from a small bridge near Hillsboro, Ill., which had been in service only ten years. The original thickness of the web was 0.2 in. The position of the most rusted portion was about 12 in. below the floor of the bridge, where a shelf angle formed a lodging place for dirt which sifted through the cracks of the plank floor. The soil is markedly acid in this neighborhood. It may be seen that unprotected steel structures in this district may become dangerously weakened within a very few years. That many more accidents have not occurred is undoubtedly due to the fact that the country in general is poor and, until recently, wood has been largely used for highway bridges.

A peculiar effect of rust action has been observed a number of times during recent years. In examining steel bridges which have been erected for some time, it has frequently been noted that the edges of thin plates, such as the cover plate of a compression member, when riveted to the flanges of channels or I-beams, frequently show a wavy or scalloped appearance. Where this occurs, the plate near the rivets is in contact with the flange of the channel but between the rivets the plate is bulged out in some cases as much as ¼ in., the space between the plate and flange being filled with dirt and rust scale. This condition is distinctly noticeable in case of the end post.

It was not immediately recognized that this buckled condition of thin cover plates was due to the expansive action of rust scale formed between the contact surfaces. That this is true, however, is evidenced by the fact that comparatively new structures do not show any appreciable buckling of thin plates between rivets, and it is inconceivable that faulty shop work should be responsible for the frequent appearance of this phenomenon in bridges built by many different shops and at different periods of time.

The volume of solid iron rust is approximately twice the volume of the metal from which it is formed and as rust scale is always more or less porous, thus still further increasing its bulk, the corrosion of a comparatively thin surface layer of each piece produces a sufficient bulk of rust scale to force the pieces apart, thereby causing the bending of the cover plate between rivets. This buckling of one of the component pieces of a compression member, of course, seriously reduces the capacity of that piece to take compressive stresses.

A remarkable instance of the expansive force exerted by rust scale was recently discovered when an examination was made of a bridge which spans Fox River at Ottawa, Ill. This structure has a single span of 234 ft., an 18-ft. clear roadway and a 7-ft. sidewalk outside of one truss. The trusses are really trussed parabolic arches having a center height of 26½ ft. It was completed in 1869. The arch members are made of **Phoenix** sections, plates and channels. The web plate of the rib on the side carrying the foot-walk, was originally about ⅝ in. thick, while in the opposite rib this plate was probably ¾ in. thick. The thickness of the metal of the Phoenix sections is about ⅜ in. The various structural sections were connected by means of ½-in. rivets spaced 6 in. apart. Owing to the thickness of metal, width of flange and shape of the section, the flanges are very stiff.

---

[*] Bridge Engineer, Illinois Highway Commission, Springfield, Ill.

A scale of rust about 3/16 in. thick had formed on each side of the web plate, between the plate and the flanges of the adjacent sections. The expansive force exerted by the formation of this scale had ruptured practically all of the rivets connecting the upper and lower halves of the ribs from one end of the bridge to the other. A length of 10 ft. of one of the arch ribs had but one unbroken rivet.

In some cases the heads of the rivets were pulled off, but usually the break was in the shank. In a few cases the head was pulled off and the shank broken as well. Examination of the ruptured rivet ends indicated, by varying degrees of corrosion, that some of the rivets had probably been broken several years, while others exhibiting almost no rust, had undoubtedly been ruptured quite recently. Some of the broken rivets show an apparent reduction of area adjacent to the break typical of a tension failure. There were no indications that this reduction was caused by rust. In cutting out the rivets, all indications pointed to a tough and ductile material.

A row of these rivets 5 ft. long was cut out and every rivet was found broken. The tenth rivet, however, was intact and when the head was cut off, a sudden jar was felt accompanied by a splitting noise, as the two halves of the arch rib separated appreciably for a length of 10 ft. or more. Right then the investigator, and others, indulged in an undignified scramble for solid ground. Nothing serious happened, however. It was found that not more than 10 per cent. of the rivets connecting the upper and lower halves of the arch ribs were unbroken. It is probable that friction and crooked shanks, due to mis-matched holes had held the parts together. There was strong evidence of a recent working of these joints. The surface steel of this bridge had been protected reasonably well with paint. Scraping disclosed a number of different colors.

Up to the present time it has been impossible to secure any material attention from local highway officials to the importance of keeping steel bridges well painted. It is hoped this matter as well as others of equal importance, may be provided for.

The Preservation of Structural Steel

By A. H. Sabin

CORROSION of structural metal (principally steel) by atmospheric and other natural causes is a subject which has long been of importance to the engineer. A few years ago, the greatly increased use of concrete structures aroused the hope that danger from such corrosion would be much reduced; but unarmoured steel seems to be used as much as ever. Concrete has not taken its place, but has made an entirely distinct place for itself. Much has been written, and much has been done, relative to the protection of steel; but improvement has been slow, progress being made step by step.

The writer can remember, when corrugated iron was introduced some thirty years ago, that it was common practice to send out with a shipment a suitable quantity of powdered iron oxide to be used as a pigment, with directions for mixing it with oil and applying it as a paint. It was supposed that, because it contained iron, it was a proper paint to apply to iron, like "applying the hair of the dog to cure the bite" (which the writer has also seen done).

Some years ago Mr. G. W. Thompson attempted to classify pigments, as to their relation with iron, by suspending them in water and immersing pieces of iron or steel in these mixtures. The results were somewhat surprising; some of the pigments which common experience approved seemed to increase corrosion in this condition, and others, known to be useless in protective paints, seemed to be much better for preventing it. Lampblack, for instance, was the worst in provoking corrosion, and white zinc or pulverised chalk prevented it. This was probably due to the fact that lampblack contains, condensed on the surface of its particles, considerable carbonic acid which is the most generally active agent in the corrosion of iron, and white zinc and chalk are basic substances by which iron is not rusted; however, the carbonic acid in lampblack is displaced by grinding in oil, and the well-known lack of durability in paints made of white zinc and chalk prevents their good qualities from coming into action.

So great is the need of more knowledge as to the value of pigments in paints and their mode of action that nothing promising new information is neglected. A committee of five chemists from different parts of the United States, with the approval of the Society for Testing Materials, made a series of tests of the principal pigments, and of some other substances, on steel immersed in water; and, as was to be expected, arrived at substantially concordant results. These results, as has been stated, were of no value from the standpoint of the paint maker, being inconsistent with the known value of the pigments when ground in oil or varnish. When the report was published, however, the pigments were classified, according to their water value, into three groups, namely, inhibitors, indeterminates, and stimulators.

This was the origin of the use of these now well-known words in paint terminology. It was expressly stated in the report that this was a classification as regards water only; but the names were so convenient and so tempting that those not familiar with the subject, and also many who saw their value for advertising purposes (two quite distinct classes), put them into common use to classify pigments in oil. It is obvious that any classification of pigments in oil should be based on their behaviour in oil, and if, as must be conceded, this is radically different from water tests, the latter should not be regarded. All this investigation began some years ago; meanwhile, numerous young men, mostly students working under the supervision of their teachers, have made brief and generally inconclusive studies of paints, and almost without exception have used these indefinite terms, inhibitors and stimulators. Patents have even been taken out—which, in the writer's opinion, are not only worthless, but invalid —covering the use of old and well-known pigments. What is worse, every maker of a paint nostrum assures his hearers or readers that his particular paint absolutely inhibits rust, and that everything else stimulates it. This is the whole history of this jargon about inhibition and stimulation; it never had any particular value to the consumer, and it is generally used to mislead him.

It is obvious that in a good paint the pigment particles are enveloped in a film of oil; they do not come in contact with the iron; if they did, the paint would peel off, for no dry pigment adheres well to metal. It is as true to-day as it has been in the past that steel rusts because air and moisture act on it; and paints are used to keep air and moisture from it. They do not inhibit rusting, except as they inhibit the cause of it.

The Improvement of Paint

The important practical question is whether paints have been or can be improved as to being non-porous and durable. This is essentially dependent on the relation between the pigment and the oil. As to the true nature of this relation, very little is known; but something is known about its visibe manifestations. It is known, for instance, that 1 lb. of dry red lead mixed with ¼ lb. of oil makes a paint of ordinary consistency, and 1 lb. of dry lampblack requires at least 6 lb. or 8 lb. of oil, say, thirty times as much, or, making allowance for difference in density, six times as much, as the red lead. Similarly, 1 lb. of white zinc takes twice as much oil to make a paint as 1 lb. of white lead; and white lead takes nearly twice as much as red lead. These are things we know; but we have no idea why they are so.

Again, red lead, which is an oxide of lead, makes an excellent paint for iron; oxide of iron is neither very good nor very bad; oxide of manganese is bad. Our knowledge of paints is as yet largely empirical; chemists dislike to admit this; for, like everybody else, they hate to confess that there is anything they do not know, and thus when a new theory is offered some of them make a great rejoicing over it without first finding out whether or not it agrees with the facts. Where we are gaining is in more general appreciation of the value of the proper application of paint, better preparation of surface, more confidence in good paint rightly used, and in the better preparation of paint materials. For instance, in the older books, and until about twenty years ago, we find analyses of red lead showing as low as 55 per cent. of true red lead, with 45 per cent. of litharge. Red lead is made from litharge, and the presence of the latter is not a sign of adulteration, but of incomplete conversion. At the same time other samples showed as high as 80 per cent. of true red lead. As is well known, there was much difference of opinion in those days as to the value of red lead as a paint for iron; though most users liked it, some thought it poor stuff. It is now known that its value depends on the quantity of red lead it contains. Coarse red lead always contains litharge, because the litharge in the middle of a large particle is never oxidized. It was observed that the finer the red lead the better it was, and so a demand arose which forced the manufacturers to make higher grades; now they are grinding their litharge to an impalpable powder before roasting it, with the result that 94 per cent. of true red lead has been on the market for some years.

Then an unexpected fact was developed. The old red lead when mixed with oil would set in a day or so —often in a few hours—into a cement, just like plaster of Paris and water; this tendency made it work with difficulty and unevenly in application, and its coarseness gave it a tendency to run; but the new, or high grade, article is inactive to oil, and brushes out smoothly like a house-paint. This enables the painter to cover 50 per cent. more surface with the same quantity and still get a coating having a uniform thickness which gives more protection than the thin portions of the paint formerly used. This secures greater economy, even at a slightly greater cost per gallon; and this is an economy not only in the cost of the paint, but in the labour, because the paint works more easily, and a man can cover more surface in a day; it also requires less skill, and therefore a less highly paid man, to do good work.

For the last year or two, red lead ground in pure linseed oil has been offered to the trade as a paste ready to be thinned with more oil; such a paste keeps for a year or more, or indefinitely as far as known, like white lead paste. Its use saves time and waste in mixing, and, being ground through a mill, the mixture is perfect, which is not the case with hand-mixing; and, as it avoids the presence of a dusty pigment, it is more sanitary.

The only serious objection to the use of such red lead is that it dries more slowly than the older kinds, This can be obviated, however, by the use of a little japan drier. There is a well-founded prejudice against the use of excessive quantities of drier in any paint; but it should be remembered that red lead paint mixed in the (standard) proportion of 28 lbs. of pigment to 1 gal. of oil, contains 20¼ lbs. of pigment per gallon of mixed paint. If this pigment contains 15 per cent. of litharge, it has 3 lb. of litharge per gallon. Now, ordinary, good, lead japan driers, or lead and manganese driers of approved quality, contain the equivalent of 1 lb. of litharge in about 3 gals. of drier; and 3 lbs. of litharge will make 8 or 10 gals. of drier. To make 1 gal. of mixed 94 per cent. red lead paint dry requires only 1 pint of drier; the rest is excess. It is much safer to add the desired quantity of drier. It may be asked why the litharge in the 94 per cent. red lead is not more active; it is probably because, when the peroxidation of the lead has been carried so nearly to completion, the particles of litharge are enveloped so completely by a dense coating of true red lead that the oil does not reach them. This is obviously not the case with the commoner and less thoroughly oxidized pigment.

It has sometimes been suggested by those not very familiar with the chemical questions involved that the litharge is the essentially valuable part of the paint, and that the red lead is only an inert extender. This is not so. The whole history of the subject shows that the improvement in red lead for paint during the last twenty-five years has been made by reducing the litharge contained in it; litharge alone, or used with other pigments, has not been satisfactory, though orange mineral, which is red lead free from litharge, is most excellent, and would be used if its cost were not so great. Further progress will undoubtedly produce red lead with a lower percentage of the protoxide; in fact, the 94 per cent. red lead now in the market usually contains much more than 94 per cent. of true red lead.

Mr. Walter S. Allward, the well-known Toronto sculptor, has received an invitation to enter a competition for the best plans submitted for the proposed Dollard Monument to be erected in Montreal.

Refuse Disposal Practice in Canadian and U. S. Cities

IN a report made recently by Messrs. Hering & Gregory, consulting engineers of New York, to the commissioners of Trenton, N.J., regarding recommendations for the collection and disposal of the city refuse, there are some interesting conclusions based upon the latest advancement in the science of refuse disposal. These also include an interesting reference to incineration plants in Canada and the United States. From the report we reproduce a few extracts concerning the functions of these incinerators.

The first furnace in America, which has not only given complete satisfaction, both from a sanitary and economical point of view, but has also utilized the heat created by the burning, is the one which was constructed in 1906 and has since been operated at Westmount, a large suburb of Montreal. It is situated not far from the residences and other buildings, burns all kinds of refuse and supplies heat for generating electricity which assists in lighting the town. As first built, the incinerator had only one furnace, having a capacity of burning 50 tons of refuse per day; the operation of this furnace was so satisfactory that a second furnace has since been added. The cost of incineration at this plant, including fixed charges, is about 52 cents per ton of refuse. Other incinerators and the years in which they went into operation are: Vancouver, 1907; Seattle, 1908; West New Brighton, 1908; Milwaukee, 1910; Clifton (Richmond Borough, N.Y.), 1912; Atlanta, Ga., 1913; Paterson, N.J., 1913, and San Francisco, 1913. The West New Brighton and the Clifton plants are both in Richmond Borough, the latter being built after the former had been found to give excellent results, and embodying some improvements. The largest refuse incinerator in the United States is that at Milwaukee, which has a capacity of 300 tons of mixed refuse per 24 hours and cost, exclusive of the land, $212,000. This has been operating for three and a half years, and a careful investigation showed that during the first three months of 1911 the total cost of operation, including interest, depreciation, etc., was $1.65 per ton. The high cost is said to be due mainly to hand operation, and it is believed that the cost could be reduced to $1.30 per ton. No funds were provided at first for the necessary equipment to produce power from the steam generated at the incinerator or to crush the clinker. Recently, however, a power plant has been constructed and completed in which electric current will be generated for operating the two stations which pump water for flushing the Milwaukee and Kinnickinnic rivers.

One of the latest refuse incinerators built along still more favorable lines is in the city of Montgomery, Ala., and has been operated since July, 1911. It consists of one 60-ton furnace of four grates with hydraulically-operated top feed doors. The refuse is mixed, consisting of garbage, rubbish and ashes, and is dumped from the collecting carts directly into storage hoppers immediately above the containers which feed into the top of the furnace. The clinkering is done by hand. The clinker falls into a car which is removed and automatically dumped by a hoisting engine and then returned. The labor has been reduced below that required at Milwaukee because of the machine feeding and clinker removal. At Paterson, N.J., and Atlanta, Ga., still greater improvements have been made which have materially reduced the amount of labor and consequently the cost of operation.

Both in Europe and in the incinerator already in operation and the second one now under construction in San Francisco, as well as in the incinerator nearing completion in Savannah, Ga., substantial reductions in operating costs are either being secured or expected.

The largest incinerator on this side of the Atlantic is that in Havana, Cuba. This incinerator was completed in February, 1913, and has a capacity of burning 500 tons of mixed refuse daily.

Describing the process of reduction, the report says: The garbage, which for this purpose must be collected separately from the rubbish and ashes, is placed in closed tanks, called digesters, and cooked for several hours under steam pressure. The cooked material is then withdrawn from the digesters and pressed to remove as much as possible of the liquids. These liquids, which carry roughly about two-thirds of the total amount of grease in the garbage, then flow to separating tanks in which the grease rises to the surface and is withdrawn. The remaining liquids, in many of the reduction works, are then allowed to go to waste, but in other works they are still further treated to recover valuable ingredients which are in solution. The pressed material, called tankage, which still contains a considerable amount of moisture, is dried to remove as much of this moisture as possible and then screened. Dry tankage thus produced is a marketable product and is used as a base in the manufacture of fertilizers.

Tankage which has been simply pressed and dried generally contains some grease, owing to the fact that it is impossible to remove all of the grease by simply pressing. The grease contained in the dry tankage can, however, be nearly all recovered by the use of the naptha process. This process consists of placing the dry tankage in closed vessels, called percolators, and then allowing the naphtha to percolate through the mass, the naphtha acting as a solvent. The naphtha with the dissolved grease is drawn off and flows to a treating tank in which it is heated to vaporize the naphtha and recover the grease. The naphtha is recovered by condensing it in a separate vessel.

Where it is desired to extract valuable ingredients in the liquids removed from the separating tanks mentioned before and from which the grease has been separated, the liquids are carried to evaporators in which a large amount of the liquid is evaporated, leaving a syrup. This syrup is then withdrawn and mixed with the tankage, which may or may not have been treated by the naphtha process, after which the tankage is dried to remove the moisture added by the syrup. Tankage thus produced is of better quality and commands a higher price.

A. D. Masson, of 30 St. Nicholas street, Quebec, dealer in contractors' supplies, has recently added a structural steel department and is now fully equipped to supply all kinds of constructional material. Recently he secured the contract for the structural steel work on the new Quebec civic hospital now in course of construction.

Structural Features of the Ryrie Building, Toronto Adapting a New Extension to an Old Building

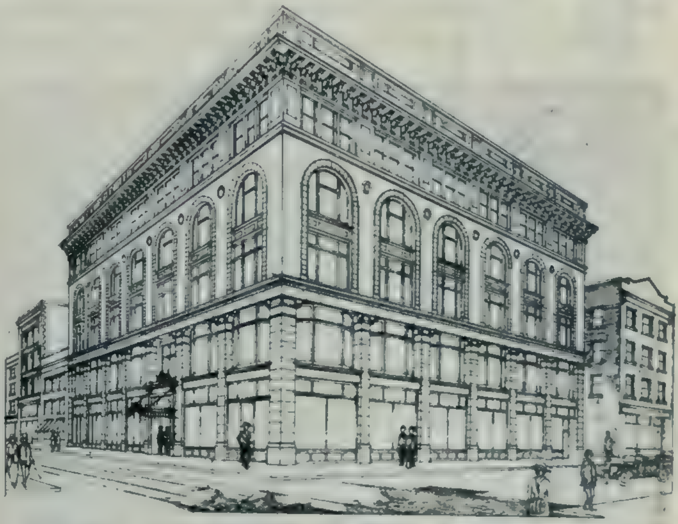
(Staff Article)

THE new Ryrie building at the corner of Yonge and Shuter streets, which has just been completed for the owners, Messrs. Ryrie Brothers, makes a notable addition to the commercial building of Toronto. The original building on the north side of the present structure had a frontage of 77 ft. on Yonge street and a depth of 120 ft., being four storeys high with basement. This building was of so substantial a character that it was deemed unnecessary to pull it down. The design, therefore, was simply taken as the standard for the new building. The result is a substantial structure which occupies commanding space on Toronto's leading down-town thoroughfare, having a frontage on Yonge street of 60 ft. and a depth of 122 ft. on Shuter street. The building is of five storeys with basement, another storey having been added to the original structure, thus making the whole block uniform in height as well as in architectural design. The old structure suggested the Italian design of architecture, therefore the aim of the architects was as far as possible to carry that atmosphere through the entire building. In a city that promises to possess so many buildings of the skyscraper type, the new Ryrie building is a pleasing variation and should add to the commercial features of Toronto. In evolving the scheme the idea of Ryrie Brothers was to erect a block where a high standard could be maintained in regard to choice of tenants, and the conditions in this respect will be such that as far as possible everything will be uniform in the way of signs and so forth.

Layout and Equipment

The building consists of stores running round the entire ground floor. There are two entrances from Yonge street, the main entrance being through a spacious vestibule to the staircase and elevator lobbies. The second, third, fourth and fifth floors are laid out as office floors, provision being made for division into a maximum of sixty-five offices. The lighting arrangements are perfect in every respect. Owing to the light courts and the enormous glass area the building is certainly amongst the best lighted in the city. Most of the windows of the upper floors are double hung, the others being casement windows. On the second, third and fourth floors, the windows are unusually large-sized with pivotted sides. The building is electrically lighted throughout, direct lighting being used, and in the way of toilet and other accommodation on each floor the arrangements are modern in every particular. In a structure of the importance of the Ryrie building provision against fire is a necessary detail. Ample protection in this respect is ensured by the installation of the "Sprinkler" system, which is fed direct from the mains. All the "Sprinkler" piping is concealed, and though this was one of the extremely difficult conditions which the architects had to meet yet it was successfully carried out. By this arrangement nothing will detract from the appearance of the building, inasmuch as there will be no unsightly pipes exposed to the view. The construction is steel frame with wood joists, all the supporting steel columns being fireproofed, and this taken in conjunction with the fact that the building is fitted with the "Sprinkler" the risk of fire is therefore reduced to a minimum. The basement in the new section of the building is a feature in itself. It consists of a room the full size of the large corner store, with terrazzi floor, and being well lighted, would be suitable for a restaurant. The heating arrangements are no less up-to-date than the other features of the building, the system utilized being steam supplied by two low-pressure return tubular boilers located in a fireproof boiler room, under an exterior court. In addition there is a domestic hot water plant which supplies water to all toilets throughout the building. Apart from the main staircase running from the basement to the fifth floor there is also an auxiliary fire stair situated in the old section of the structure. Two sets of fire escapes have also been provided on the public lane at the rear.

The building is divided by a brick wall running from the bottom to the top, hall openings being protected by "Underwriter" fire doors concealed in "pockets." The cornice running around the building is of copper with a sufficient projection to throw a strong shadow line around the structure. In the spandials between the large semi-circular head windows are polychrome terra cotta medalions which add to the artistic features.



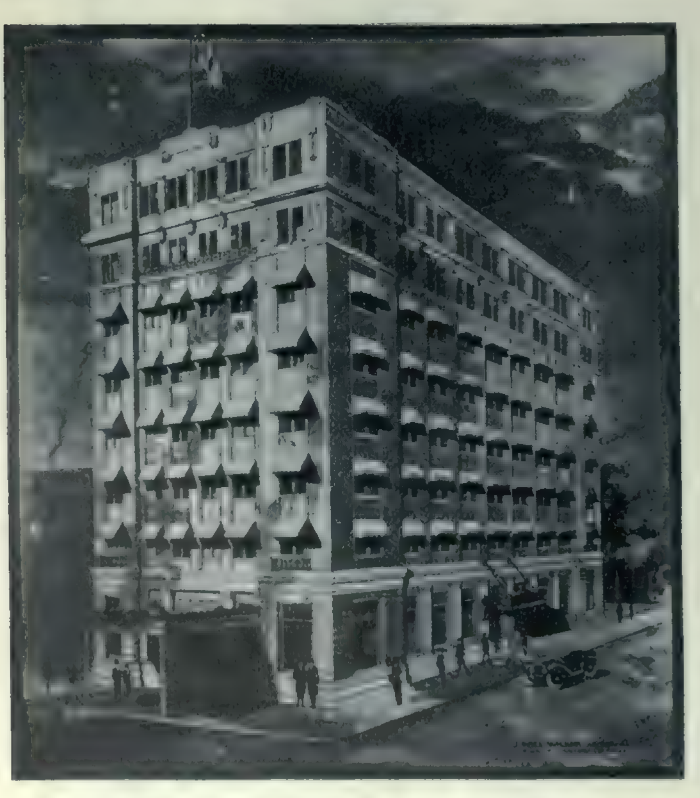
The new Ryrie Building, Toronto. Architects: Me Burke, Horwood & White.

The materials used in construction are Milton pressed brick with Portage Entry stone trim on the two lower floors, and terra cotta trim on the upper floors. The brick used in the building is the fumed flash brick which the Milton Pressed Brick Company have been making only during the past year. It is an exceptionally hard burned brick running from a light tan to a dark brown color. The entrance vestibule, hall, staircase and elevator halls are finished in statuary veined Italian marble, with Botticino trimming. The stairway from ground floor to basement, and from ground floor to second floor, is of marble with ornamental iron railing.

The architects who carried out the work with characteristic efficiency are the firm of Messrs. Burke, Horwood & White, Toronto. The contractors were: Messrs. Elgie & Page, masonry; Black Building Supply Company, Toronto, Agents for the North-Western Terra Cotta Company, Chicago, supplied the terra cotta trim; J. C. Scott Company, Limited, carpentry; Mr. R. C. Dancy, plastering; A. Matthews Limited, sheet metal and roofing; Messrs. Fred G. Roberts & Company, painting and glazing; Canadian Allis-Chalmers Company, architectural iron and bronze; Toronto Structural Steel Company, Limited, structural steel; Bennett & Wright Company, Limited, heating, ventilating, plumbing and wiring; this firm also installed the "Sprinkler" system; and Norcross Brothers carried out the marble work.

Proposed New Hotel for Windsor, Ont.

BY the courtesy of the architect, Mr. J. W. Wilson, we are enabled to present herewith a perspective view of the proposed Windsor Hotel which is to be erected at Windsor, Ont., at a cost of some $350,000. The building will be of reinforced concrete throughout. The exterior will be of cut stone, terra cotta and glazed brick. On the ground floor there will be a large rotunda, public and private dining rooms, writing room and all the other accommodation provided in an up-to-date city hotel. The basement will contain barber shops, sample rooms, billiard room, kitchens, heating and ventilating plant. There will be approximately 150 bedrooms—all equipped with separate baths and wardrobes. The upper floor will be arranged to accommodate conventions, balls and other functions. It is hoped to start operations before the end of March and to complete the erection of the hotel and open it for business in about six months.

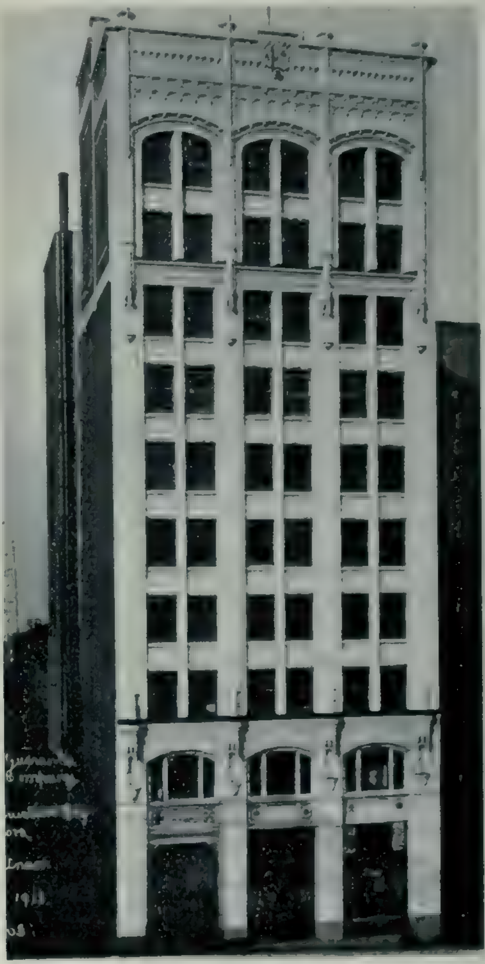


Proposed Windsor Hotel, Windsor, Ont. Architect: Mr. J. W. Wilson, Detroit. Estimated cost. $350,000.

The architect, Mr. Wilson, whose offices are at Detroit, Mich., and Chatham, Ont., is a Canadian by birth and is a member of the Ontario Association of Architects.

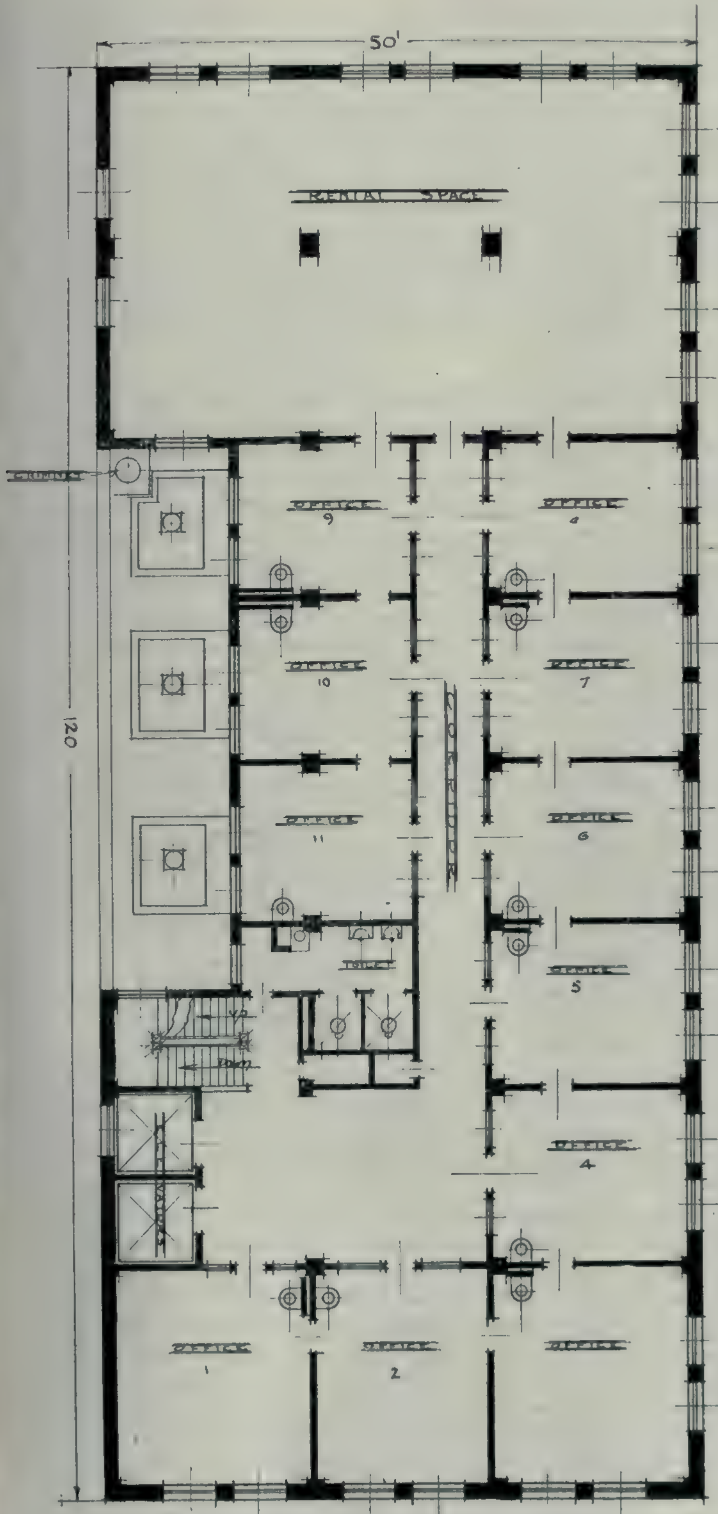
Another Ten-Storey Office Building for Vancouver

THE Yorkshire Building, Vancouver's newest office block, is located on a site on Seymour street, between Pender and Dunsmuir, chosen with a view to providing the various offices with plenty of light, there being an unobstructed space on all sides. This structure is ten storeys in height and has a frontage of 50 feet and a depth of 120 feet. The construction is reinforced concrete, with pressed brick for the side walls and white glazed terra cotta for the front elevation, the design being carried out very successfully in an imposing Gothic style. The foundations on the street frontage are of granite, extending to a height of about three feet above the level of the sidewalk. The main entrance lobby, twenty feet in height, is decorated from floor to ceiling in terra cotta, the detail around the top being heightened with gold leaf treatment which provides a most attractive contrast. The flooring of this space is in marble, as is also the flooring of the elevator hall, the walls of which are finished in Rubio "G" marble. All corridors are wainscotted to a height of three feet with glazed tile and floored in terrazzo. The corridors are well lighted, this being due to the fact that above the wainscotting the walls are composed almost entirely of glass. The ground floor has been fitted up for carrying on a general banking and trust business, and will be occupied by the Yorkshire Guarantee and Securities Corporation, Limited, and the Yorkshire



Front elevation, Yorkshire Building, Vancouver. Architects: Messrs. Somervel & Putnam, Vancouver. Estimated cost, $300,000.

Insurance Company, Limited, the joint owners of the building. The floors of the banking rooms are finished in terrazzo with marble baseboards, and the counters and office partitions are to be of selected oak, this wood being used as interior finish throughout the building. A commodious private office for the assistant manager and the staff has been provided on this floor in addition to a reinforced concrete vault. The manager's office, situated on the mezzanine floor, is panelled from floor to ceiling in oak, and immediately adjoining there is a large room finished in the same style for the use of the directors. A feature in the construction is that the building has been left without partitions on seven of the upper floors, excepting in the corridors, this arrangement enabling tenants to suit their own requirements. The floors of all offices are covered with cork linoleum. The typical floor contains eleven single offices, and a suit at the rear comprising five offices. The toilets throughout the building are excellently lighted and ventilated, and are fitted with white porcelain basins. The walls are of white ceramic tiles. The Webster vacuum system of heating has been installed. All electrical work is laid in fireproof conduits.



Typical floor plan, Yorkshire Building.

Messrs. Somervel & Putnam, Vancouver, designed the building, and the work of construction is being carried out by the Dominion Construction Company, also a local firm. The cost complete is estimated at approximately $300,000.

The reason why oil paint will not stand well on concrete surfaces is that the oil is saponified by the free lime of the cement. It is stated in a French architectural journal that this drawback can be obviated by first applying a wash of zinc sulphate in the form of a 1:5 solution, the result being to produce a film of plaster and zinc oxide which is quite harmless to oil.

Seattle harbor improvements to the amount of $21,300,000 have been executed or authorized. The improvements include dredging and the construction of a canal, lock, warehouses and cold-storage plants. These and other facts are given in a paper by Charles Evan Fowler in the "Extension Journal" of the University of Washington. The paper summarizes important data of most of the large seaports of the world and reviews the principal types of docks, piers and equipment. It estimates the cost of port development in a number of important cities—$186,700,000 for London, $125,000,000 for Liverpool, $100,000,000 for Hamburg, $83,500,000 for New York and $90,000,000 for Manchester.

The question is sometimes asked whether concrete reservoirs are suitable for the storage of oil. We may, therefore, usefully refer to the experience of the Atchison, Topeka and Santa Fe Railway Company, as briefly summarised: On the Abuquerque Division concrete lined reservoirs have not been affected by oil; on the San Joaquin Valley Division several concrete linings have been used for oil reservoirs and sumps, and no special effect of the oil has been observed; on the Arizona Division concrete lined oil sumps are used, and although the oil is at a comparatively high temperature the concrete in the sumps has not shown any sign of deterioration.

New uses for concrete never cease. The latest is a concrete automobile sightseeing tower, which it is proposed to construct in Denver. It is to be 200 ft. high and 200 ft. square at the base and to have encircling it an automobile road up which cars may run with ease, for the maximum grade will be 3 per cent. The distance by the road from bottom to top will be 1,500 ft., and on top will be a 100-ft. square platform on which the machines can be parked without difficulty. The estimated cost is $100,000. The tower is elaborate in conception and promises to afford a means whereby automobile tourists may see the mountains from the city of Denver without leaving their cars.

New Power and Waterworks Plant, Merritt, B.C.

By N. M. Hall, Supervising Engineer

SOON after the incorporation of the city of Merritt, B.C., steps were taken by the new council to add to the rapidly growing city a much needed waterworks system, and at the same time an up-to-date electric plant to replace the small privately-owned system formerly in service. Messrs. DuCane Dutcher & Company, consulting engineers, of Vancouver and Calgary, were commissioned by the city to look into the situation, and in June, 1912, were able to present a report favorable to the installation of a steam generating and pumping plant, and the necessary electric power and waterworks distributing systems. Generation by steam was recommended on account of the proximity to the extensive coal mines of the city from which fuel was obtainable at a reasonable cost. A gravity water system was not favored due to the excessive cost of pipe lines, but was reported on as a possible future undertaking. The source of water is the Coldwater river, a mountain stream of considerable size, and the pumps were to pump directly into the city system with an overflow tank on an adjacent hill to provide a head of about 25 feet. In July, 1912, the report was accepted, and the necessary money bylaws passed by the city.

The site chosen is on the east bank of the Coldwater River, about 300 feet from the stream. The choice was made in order that the water would be thoroughly filtered in percolating through the gravel bank to the pump well, which is located partly under the power house building. This well is approximately 6 x 10 x 13 ft. deep, and connects by two 8-in. pipes with another well 6 x 20 x 8 ft. deep, located towards the river. Both wells are sheet piled to prevent gravel falling in, and the outer one is arranged with close screens to permit of easy cleaning.

The building, which is of reinforced concrete with wooden trusses supporting a corrugated iron roof, was erected by Fowler & Larsen, local contractors. An intermediate wall divides the boiler room from the engine and pumproom. In each end is a centrally located double sliding door, and in the boiler room on opposite sides are smaller doors, one near the stack for the removal of ashes, and the other for wheeling in coal from the adjacent coal tracks. A concrete floor in the engine room covers all except the entrance to the wiring and rheostat pit behind the switchboard.

The boilers, stack and feed pumps were supplied by the Canada Foundry Company of Vancouver. The boilers are return tubular 72 x 18 ft. in one battery connected by a circular steel breeching to the 48 x 65-ft. steel stack just outside the building. The duplex feed pumps are for use in emergencies only, as the city water pressure will feed the boilers under ordinary conditions. The Griscom Spencer closed feed water heater was supplied by the Chas. C. Moore Company, of Seattle. This type was chosen in preference to the open type on account of the little attention required due to the excellent quality of feed water.

The generator unit consists of cross compound vertical high speed Goldie-McCulloch non-condensing engine direct connected to a Canadian General Electric Company 125 kv.a., 2200 volt, 3-phase, 60 cycle, with direct connected exciter. The unit runs at 450 r.p.m., has forced lubrication and sensitive governor, and complete set of gauges and tachometer.

The switchboard and all wiring and conduit installation was supplied by the Canadian General Electric Company. The board, which is of blue Vermont marble, consists of one combined generator and exciter panel and three feeder panels, as shown in the accompanying photographs. All wiring is in conduit and all lines lie under the floor, and extend up the wall to the outlet in lead cable in conduit.

The rheostat pit is under the switchboard and suspended from the ceiling are the instrument transformers. The pit is concrete lined and damp-proof. The pumps, which are each of 400 gallon per minute capacity, are located as shown in the accompanying plan, and directly over the suction well. Both were supplied and installed by the Canada Foundry Company. The single stage pump is driven by a Terry noncondensing steam turbine at 2100 r.p.m. and is intended for a standby in case of fire or emergency. The other is two-stage, 1750 r.p.m. Mather & Platt type and is driven by a Canadian General Electric Company 55 h.p., 2200 volt wound motor. The secondary grids are located in the rheostat pit, and the controller is shown near and to the rear of the board.

The constant current transformer for the series street lighting circuit was supplied by the Canadian General Electric Company. Included is the control panel with plug switches, and lightning arresters. The capacity is 10 kw. and controls a 40-lamp, 7.5 ampere circuit. At present only one 3-phase circuit leaves the station, and the spare panels are used to control the motor-driven pump and the series circuit respectively. These connections are temporary only as these panels can at any time be used for additional circuits.

The present overhead distribution consists of a 2200 volt, 3-phase circuit with 110 volt secondaries and a single phase 2200 volt series circuit operating street lamps. The latter circuit is of No. 8 W.P. wire, while No. 6 and No. 8 W.P. is used on the three-phase and secondaries and arranged to give the best voltages. The transformers, including that for the station lighting, are the standard C.G.E. Co. pole type and protected by primary fuse plugs. The street lamps were supplied by the Canadian General Electric Company and are hung from No. 10 Messenger wire spanning the street and isolated by two suitable strain insulators. The series lamps are 200 watt and 7.5 ampere.

The Waterworks System

The waterworks system consists of an 8-inch main leading from the pumps to the city system, and thence to the 50,000 gallon reservoir on the hill opposite. The city system consists of a network of 6 and 4-in. pipe, fully equipped with isolating valves and hydrants. All pipe used was steel, hub and spigot, and supplied by Robertson Godson & Company, of Vancouver. The seventeen hydrants were all of the modern Ludlow type.

The wood stave tank was supplied by the Municipal Construction Company, Vancouver. A tell-tale visible from the power house indicates the water level. The overhead wiring was installed by A. B. Kennedy, local electrical contractor, and the machinery, switchboard and connections by the Canadian General Electric Company. The boiler installation and piping, as well as the waterworks system, were put in by day labor.

About March 10th, 1913, the power was turned on the city, and about the same date the waterworks system was put into commission. A pressure was obtainable at each hydrant of 100 lbs. per square inch, which gives ample fire protection. The water filtering through the natural gravel bed is of good quality and quite free from sediment and scale-forming impurities. The plant, since being put into commission, has run practically without interruption and the city has a plant with ample capacity and reliability to meet the demands of the city and district for at least five years to come. The design and supervision of the work were in charge of DuCane, Dutcher & Company, consulting engineers, Vancouver and Calgary.

Toronto the Mecca of Good Roads Enthusiasts Last Week

The Twelfth Annual Convention of the Good Roads Association of Ontario

The Twelfth annual meeting of the Good Roads Association of Ontario opened at York County Council Chambers, Toronto, on February 24 and concluded on February 26. The president, Mr. M. Vermilyea, of Belleville, presided, and there was a large attendance of delegates from various parts of Ontario. The morning session was taken up with the report of the Executive Committee, followed by the presidential address, appointment of committees, and address by Mr. L. S. Squire, of Waterford. At the afternoon sessions Mr. Canby Wismer, of St. Catharines, read an interesting paper on "Trunk Roads," and "County Roads" was the subject of a paper read by Mr. John A. Vance, of Waterdown, Wentworth County. Mr. H. D. Cleminson, of Prince Edward County, urged better inspection of roads, especially when they were being built, but believed in a system of trunk roads, and in the government providing a short course for road superintendents and foremen in order to instruct them in drainage and other necessary training in road building. Mr. W. D. Flatt, of Hamilton, spoke in favor of the building of concrete highways.

Mr. E. A. James, County Engineer of York, who addressed the convention on the subject of "County Roads," said he was in favor of sub-division of road systems into township and county and trunk systems. He did not think roads should be classified, but that everybody should try and make every road the best for the general travelling public. The trouble in his opinion was the financing of the problem.

Wednesday's session was opened with a paper on "Township Roads," read by Mr. Chas. Bush, of St. Catharines. He said that townships were slowly but surely being brought into line with the good roads movement, and in many places were considering the necessity of building for the future. He thought that in all organized townships statute labor should be abolished and replaced by a business-like system under central control. Every county should have a good roads system association, and every board of trade a good roads committee. The cities, he thought, should contribute a fair share towards the upkeep of the county and all main roads connected with the principal thoroughfares. An important item of handwork, which was so often neglected, was the keeping of old ditches and culvert outlets open. The frequent source of trouble in macadam roads was that of allowing the earth sides to be higher than the edge of the stone, thus preventing water from running off easily. The earth sides of the stone road needed constant attention, and should be smoothed down with a drag. An interesting discussion followed in which Mr. J. W. MacLeod, of Cornwall, Mr. Chas. Ketcheson, of Belleville, and Mr. J. H. Garbutt, of Peterborough, took part.

A paper on "Roads of Queen Victoria Park," was read by Mr. J. H. Jackson, of Niagara Falls, and Mr. A. F. Macallum, C.E., Hamilton, followed with a paper on "City and Town Streets." The ideal road was one that was clean, sanitary, noiseless, and not slippery, and in his opinion would soon come. It was impossible to maintain good roads in cities with the present poor system of laying car tracks.

Prof. Laing, of the University of Toronto, spoke on the need of training men employed in road construction. Courses were now being given in the university and everybody should take advantage of them, and make themselves still more fit for the positions they were occupying at the present time.

Mr. C. A. McGrath, of Ottawa, Chairman of the Ontario Highway Commission, in an able address, said it was not particularly the trunk roads that the commission was looking after, but all roads in the province that would meet the demands of the people.

Mr. W. A. MacLean, Chief Engineer of the Commission, spoke in favor of abolishing statute labor on roads, stating that in his experience it was detrimental to the building of good roads.

Suggested Amendment to Highways Act

The following resolutions were unanimously passed:—

"That the Municipal Act and the Highway Improvements Act should be amended so that moneys raised by debentures for highway improvement purposes, and the amount received from the Provincial Treasurer on account of expenditures under the Highway Improvements Act, shall form a special fund to provide for expenditures under the Act.

"That the convention places itself on record as being in favour of the abolition or commutation of statute labor in organized townships.

"That the Government be asked to extend the provisions of the Highways Improvements Act to organized townships that have abolished or commuted statute labor, and established a good organization for construction and maintenance.

"That we approve of the recommendation of the executive for an increase in cost of motor vehicle licenses and taxation of railways to form a fund for highway improvement purposes."

At the afternoon session an address was given by Hon. Dr. Reaume, Minister of Public Works, Ont. This was followed by an informative paper read by Mr. L. E. Allen, of Belleville, Engineer of Hastings County. He traced the history of bridges from the time of the first cast-iron structure in 1850 down to the erection of the steel bridge about 1875, pointing out that the first concrete arch was made in France in 1869. Discussing bridge building in Hastings County, Mr. Allen said it was customary in that county to put a few inches gravel on top of concrete bridges so as to get rid of the smooth surface of the concrete. He advised the township councils to make a thorough and accurate survey of all bridges and bridge work in the township, and that all possible data be secured before construction was begun.

An interesting discussion followed, in which Mr. Frank Barber, C.E., Bridge Engineer, York County, and Mr. C. R. Wheelock, Orangeville, Engineer of Peel County, took part.

The convention concluded early on Thursday when papers were read on "Dragging Earth Roads," by Mr. A. Denholm, of Blenheim; "Value of Roads to Cities and Towns," by Col. W. N. Ponton, Belleville; and "Haulage of Farm Produce," by Mr. Robert Thompson, St. Catharines.

Election of Officers

The election of officers for the ensuing year resulted as follows:—Hon. Presidents, Messrs. T. L. Kennedy and N. Vermilyea; President, Mr. J. A. Sanderson; First Vice-President, Mr. S. G. Squires; Second Vice-President, Mr. K. W. MacKay; Secretary-Treasurer, Mr. George S. Henry, M.P.P. Executive Committee, Messrs. F. A. Senecal, T. E. Allen, R. H. Lush, J. J. Parsons, W. H. Pugsley, and C. R. Wheelock.

Excavating is completed and work will begin shortly on stores and offices to cost $100,000, at Swift Current, Sask. Mr. M. Healey, Toronto, is the architect.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

Mr. C. Chapois, district engineer, with headquarters at Quebec, has sent in his resignation to the Department at Ottawa.

Mr. Joseph Giroux, Quebec, has secured the contract for a $175,000 church at Jonquiere, Que. The architect is Mr. J. P. Lemay, Quebec.

The Dominion Government is appointing a commission of three to consider the commercial feasibility of the Georgian Bay Canal project.

A company with $100,000 capital, including Boston as well as local investors, has been organized to erect a hotel at St. John, N.B., at a point seventeen miles up the river.

Contract and sub-contracts are being awarded for an addition to the University of Ottawa estimated to cost $150,000. Mr. C. P. Meredith, of the federal capital, is the architect.

Plans are in course of preparation for a new church at the corner of Grace and Mansfield streets, Toronto, to involve an outlay of $100,000. Mr. A. W. Holmes, Toronto, is the architect.

Mr. H. Dunlap Morrison, of Montreal, is the architect for the new office building being erected in that city at an estimated cost of $200,000, upon which tenders will be invited within a month.

A joint committee of Montreal aldermen and controllers will study the report of the engineering department recommending the construction of three subways for electric cars at an estimated cost of $20,000,000.

The Montreal Council have voted an appropriation of $1,000,000 for the construction of sewers. The largest amount was for $510,000 for the construction of a trunk sewer in Emard Ward, St. Paul and St. Gabriel Wards.

The city of Peterborough, Ont., has had plans prepared for a sewage disposal system estimated to cost $100,000. If the plans are approved by the Provincial Board of Health, tenders will be called by the City Engineer, Mr. R. H. Parsons.

The Dominion Government has granted $40,000 towards the cost of a lift bridge to cross the Rideau River at Pretoria Avenue, Ottawa. Plans are being prepared by Mr. A. Currie, City Engineer. The structure will cost about $120,000.

The town of St. Lambert, P.Q., have sold bonds to the value of $480,000, which sum will be expended in the extension of concrete sidewalks, asphalt, bituminous macadam and concrete pavements, water mains and storm sewers, street widening and standard-lamp street lighting.

Leave to appeal against the judgment of Mr. Justice Lennox, quashing the Ottawa Water Works by-law, has been granted by the Appelate division at Osgoode Hall. The trial judge ruled that the by-law was bad as the city proposed to spend $8,000,000 on the new system, which was $3,000,000 in excess of the amount authorized to be spent by the legislature without a vote of the ratepayers.

Subject to the approval of the ratepayers, the city council of Westmount, P.Q., will borrow $1,210,000 for public improvements. This sum will be spent—$350,000 on new municipal buildings, $160,000 for expropriating a street, $250,000 for improving the street lighting and placing the wires in underground conduits, $200,000 for paving private lanes, and $250,000 for street extension and paving.

Messrs. Jamieson, Lea, and Heckle, the experts employed by the Montreal Controllers, have made their report on the break in the water conduit. It is a long document, and deals in detail with the causes which led to the break. The work of repairing the conduit continues; the concrete work has been strengthened in every direction, and although there are leaks, means have been taken to ensure that they will not lead to any damage.

The Montreal Harbour Commissioners have asked the Government to provide $15,000,000 to be spent during the next five years. The expenditure this year is estimated at $3,000,000, the programme including additional pier and shed facilities. Two new steel and concrete piers for ocean liners will be constructed, while the wharves will also be extended. A large sum will be needed to complete the work in connection with the Vickers drydock at Maisonneuve, P.Q.

A deputation from Montreal have visited Ottawa and asked the Government, through Mr. Borden, to guarantee fifteen million dollars, interest on bonds to be issued for constructing a tunnel connecting Montreal with the south shore of the St. Lawrence. The tunnel, it was asserted, would give much-needed independent access to the city for railway purposes, and will provide a broad avenue to the south for traffic which must accrue to Montreal from the building of the Transcontinental.

Messrs. Marsh, Hutton & Powers, who have obtained the contract for the construction of a new Government Customs building at Port Arthur, have commenced the construction of the building, which will have a frontage on Arthur street of 160 ft., and of 70 ft. on Water street. The basement storey is to be of stone, while the remainder of the building will be of pressed brick with stone trimmings. The building will be fire-proof throughout, being constructed of structural steel, of which over 400 tons will be used, and reinforced concrete. The building will cost approximately $250,000.

In his annual report to the twenty-second annual meeting of the Association of Ontario Land Surveyors, which was held in Toronto recently, the president, Mr. J. S. Dobie, of Thessalon, said that with the opening up and colonization of Northern Canada, the construction of a new system of roadways throughout the different provinces, and the extensive railroad construction going on, the prospects were bright for surveyors. Mr. H. O. Dempster read a paper on "Surveys in British Columbia," and Mr. H. T. Routly, of Haileybury, contributed a paper on "Contour Survey of the Abitibi River."

Constructional work in Fort Frances, Ont., showed marked development during 1913. A total of $3,044,250 was expended on improvements during the year. The more important of these works included the construction of the Ontario and Minnesota Power Company's building at a cost of one and a half millions; the Shevlin-Clark Company's No. 2 mill, $350,000; the Johnson-Carey Company (rock fill), Rainy Lake, at a cost of $380,000; the Canadian Northern Railway Company, passenger station and improvements, $50,000, and the new building for the Canadian Bank of Commerce at a similar amount.

Mr. A. Currie, city engineer of Ottawa, has issued a report on Mayor McVeity's pure-water scheme for the city. The Mayor's suggestion is to take the water from the Ottawa River at a point not higher up than Brittania Bay on Lake Deschenes, by an all-land pipe from the Ontario shore to the present pumping station, with a low service reservoir and rapid sand filtration. Mr. Currie's report, which endorses the idea, recommends a point beyond Ramoux and Little Chaudiere Rapids as the location for the intake, thus securing the water supply some distance above the point where the river becomes seriously polluted. The cost of construction is estimated at $1,700,000 and the cost of operation $89,000.

The St. John city council has received a report from Clarence Goldsmith, an American expert, who recently made an investigation of the city's water supply. As a result of his recommendations the city will lay sufficient additional water pipe to gridiron the most important section of the city, and will also take action as will very considerably increase the pressure at the point where the great mains enter the city. A better system of fire hydrants will also be provided, and other changes made which will greatly improve the general distribution service, and its efficiency in the event of fire. The city is fortunate in the possession of a gravitation water supply of the water from Loch Lomond, ten miles distant, while the western side of the city is supplied from Spruce Lake. Mr. Goldsmith made a very careful investigation of the whole system and his report will be made the basis of future work of improvement.

WESTERN CANADA

Winnipeg building permits for January and February total over $1,000,000.

The Manitoba Government has voted $2,500,000 to be used under the Good Roads Act.

Paving work estimated to cost $750,000 is one of the items on Edmonton's constructional programme for 1914.

A good building season is predicted for Edmonton during this year according to a recent statement made by Mr. N. A. McIvor, building inspector.

Tenders have been called for extensions of the water pipe line to new wells at Winnipeg, at a cost of $234,150. The work is in charge of Mr H. N. Ruttan, Winnipeg.

The Burrard Peninsula joint sewers commission is to spend approximately $2,000,000 in Greater Vancouver this year, according to a statement made by Frank Bowser, chairman.

A site is reported to have been secured for a $1,000,000 college to be erected at Regina, Sask., by the Saskatchewan Presbytery. Grants for the building have already been obtained.

An elevator of reinforced concrete and brick construction, estimated to cost $300,000, is to be erected at Regina, Sask., on a site donated by the city to Messrs. Leitch Bros., of Oak Lake, Man.

The Pantages interests of Seattle, Wash., contemplate the erection of a new theatre estimated to cost $250,000, at Vancouver, B.C. Mr. B. M. Pretica, of Seattle, is named as the probable architect.

The British Columbia Construction & Engineering Company, of Victoria, the general contractors for the new departmental store of the Hudson's Bay Company at Victoria, are planning to start work at once. The building will be of steel and concrete construction and will cost something like $1,250,000.

Plans prepared by Professor Stoughton, head of the Department of Architecture at the University of Manitoba, have been approved by the University Council for the grouping of the new University buildings at St. Vital.

At an estimated cost of $1,000,000 a twelve-storey hotel of steel and tile construction is being erected on Smith street, Winnipeg. The architects, Messrs. James Chisholm & Sons, are receiving private tenders for the work of completion.

A new three-storey apartment block, to be of stone foundation, brick construction and felt and gravel roofing, and costing $200,000, will be erected in the spring in Winnipeg. The architects, Messrs. Jordon & Over, will receive tenders until April 15.

The first floating wharf to be constructed by the Dominion Government on the west arm has been completed at Hallett's Landing, opposite Harrop, Western Canada. The first wharf of this type to be completed in Kootenay Lake waters was at Argenta.

The Saskatchewan Government, through the highway commission, has decided to repeat the innovation of last year by holding a competition during 1914 for the maintenance of roads by using the road drag. All organized municipalities will be invited to enter the contest. As there is much interest in the question of good roads the competition this year should be keen.

The claims of Vancouver for the grain elevator to be established by the Dominion Government on Burrard Peninsula are being strongly urged by the board of trade of that city. It is understood that a site on Burrard Inlet, near the location for the new government dock now under construction between Salsbury and Commercial drives, will be recommended to the grain commission.

Mr. T. H. Navin, of Moose Jaw, was elected President of Saskatchewan Builders' Exchange at the recent convention. It was decided that the interests of the builders, as far as affected by the proposed legislation, will be looked after by a committee of Regina contractors. The Architects' Association of Saskatchewan will be asked to take steps to have the amended Winnipeg Builders' Exchange form of uniform contract used exclusively on all work in future.

There is every possibility that the construction of a ten-storey office building for Weiler Bros., Limited, of Victoria, the well-known firm of house furnishers, will be undertaken during the coming spring. So far as can be learned, the structure will be a massive affair of steel, concrete and brick construction, costing about $250,000, and will occupy a site comprising 120 x 120 feet at the corner of Douglas and Kane streets. Mr. A. A. Cox, Vancouver and Victoria, is the architect.

At a meeting of the Canadian Mining Institute in Vancouver recently, Mr. E. E. Campbell, chief engineer of the Granby Consolidated Company, announced in connection with the copper mining operations of the firm that a complete reduction plant with three blast furnaces, having a capacity of about two thousand tons a day, was in course of erection. He also stated that the company had acquired other properties and intended soon to start development in Alaska where a plant will be put down almost immediately.

Nine million dollars is the estimated expenditure for civic improvements in Edmonton during 1914. This includes $2,164,196 for sewers and $1,125,330 for waterworks and a filtering plant. These extensions have been authorized by the city council, and it is expected that work will begin early the coming spring. Architects and contractors estimate that buildings costing fully $10,000,000 will be erected this year. One of the important structures is the McLeod building, costing $900,000. Another projected building is a ten-storey hotel, costing $500,000, and a church building to cost $100,000 for St. Joachim's congregation.

A deputation representing the civil engineers of British Columbia waited on the executive council recently with a protest against a clause in the Municipal Act, which they hold gives the municipalities of the province practically the right of interpretation of the term "civil engineer." It was suggested that the definition of the term should be "one who is a member of the Canadian Society of Civil Engineers, or the sister organization of Great Britain, or some society for which the qualifications of admission to membership were recognized by these two parent societies." The Premier promised that the matter would receive the consideration of the Executive Council.

Messrs. Davis & Leslie, consulting engineers, Vancouver, have been entrusted with the laying out of the North Fraser harbor, B.C. Col. Davis, who is a member of the Canadian Society of Civil Engineers, was the first graduate to pass the Royal Military College, Kingston. He was well-known in Eastern Canada as a successful engineer, having carried out many important works. Major Leslie, who is a member of the Institute of Civil Engineers as well as of the Canadian Society, has had world-wide experience in railway and harbor works. The firm are the representatives for British Columbia of the well-known English harbor engineers, Sir Douglas Fox and partners.

Canadian Railroad Development

Announcement is made that construction work on the Alberta and Great Waterways Railway, from Winnipeg to Fort McMurray, will begin within ninety days.

Messrs. Hyland & Galloway, contractors for the work of extending the Grand Trunk Pacific line from the town of Harte to Brandon, Man., have their outfit ready to commence the grade at the opening of spring.

The Newfoundland Railway and Train Ferry Syndicate, Limited, have been given authority to construct, equip and operate a line of railway from the south-west arm of Green Bay to the Humber Mouth, Bay of Islands.

A survey for an extension of the Temiskaming and Northern Ontario Railway having been finally made, construction is expected shortly to commence. The survey extends from Elk Lake to Gowganda, and will connect by a continuous line of railway Sudbury, Gowganda and Cochrane.

A bill has been introduced in the Dominion Parliament advocating the building of a line of railway from Woodstock and Hamilton, through Brantford; from Hamilton to Niagara Falls via St. Catharines, with branch lines from Hamilton to Toronto, and from Woodstock to some point on Lake Huron, The bill seeks to extend the charter to the South Ontario Pacific Railway Company. This charter is 27 years old, and only 16 miles of road are built.

The Transcontinental Railway Company of Canada is having a Canadian car-ferry and ice-breaking steamer built by the Campbell Laird Company, of Birkenhead, Eng. The vessel is intended for service on the St. Lawrence, between Quebec and Levis. Its principal dimensions are: length, 326 ft.; beam, 65 ft.; with a draft of 15 ft. Trains are carried to a tidal deck arranged above the main deck of the steamer on three lengths of track, each of which is about 272 ft. long.

The Canadian Pacific Railway is projecting a five-mile double-track tunnel through Mount Macdonald, B.C. The enterprise is officially known as the Rogers Pass tunnelling scheme, and the related improvements will involve an expenditure of more than $10,000,000. The tunnel will rank as the longest railway bore on the American continent. The work is expected to be completed by December 31, 1916. It will mean the elimination of "loops," miles of snowsheds, will reduce the distance by four miles, and effect a big grade reduction as well.

The Canadian Pacific Railroad extension plans involve a total expenditure of approximately $35,000,000. There are 133 miles of double-track under way between Sudbury and Port Arthur, to cost $6,000,000; 178 miles double-track between Brandon and Calgary, to cost $5,000,000; and 139 miles between Revelstoke and Vancouver, to cost $7,000,000, in addition to other works. Before the company is through with its present programme of construction, including the irrigation works, the double-tracking, and the new trackage (amounting to about 1,200 miles), it will have expended about $450,000,000 in the western part of the country since its inception.

Personal Mention

Mr. C. H. Topp is the new engineer for Esquimault, B.C., in succession to Mr. W. E. Casey, resigned.

Mr. E. R. Bingham has been appointed corporation surveyor for Port Arthur in succession to Mr. A. L. Russel, who recently resigned.

Mr. Joseph Copeland, who had been inspector of sidewalks for North Toronto for some years past, died on February 18 after a short illness.

Mr. J. Antonisen, C.E., has resigned his position as superintendent of the Brandon Street Railway Company. He was formerly city engineer of Port Arthur and later of Moose Jaw.

Mr. H. F. Christie, assistant city engineer on bridges, read a paper on "The Low Level Bridges Across the Saskatchewan at Edmonton," before a meeting of the Edmonton Engineering Society recently.

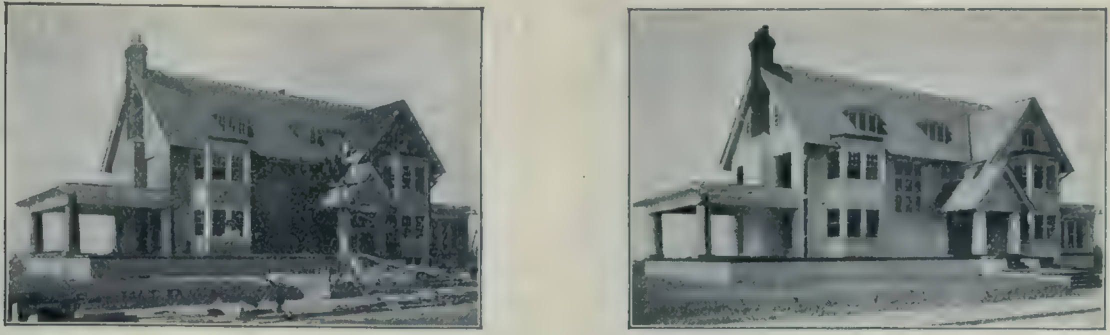
Mr. J. W. Kirkpatrick, of Peterborough, has been elected president of the Association of Ontario Land Surveyors. Mr. E. T. Wilkie, of Toronto, vice-president, and Mr. L. W. Rorke, also of Toronto, secretary-treasurer (re-elected).

Mr. George P. Hemstreet, Superintendent, the Hastings Pavement Company, Hastings-on-Hudson, N.Y., recently delivered an illustrated lecture on "The Manufacture of Asphalt Blocks" before the Graduate Students in Highway Engineering at Columbia University.

Mr. J. E. Jones, Civic Stone Inspector, of Toronto, died on February 23 from an attack of apoplexy. The death of Mr. Jones is the third in the City Arcritects' Department since the opening of the investigation recently, Mr. James E. Riddell, Chief Building Inspector, having passed away on February 20.

Mr. Henry W. Thornton, General Superintendent of the Long Island R. R., Jamaica, has been appointed General Manager of the Great Eastern, the largest railway system in Great Britain. The company possesses 1,217 miles of track over 1,000 locomotives, 5,400 passenger cars, 27,000 freight cars, and 17 steam boats.

Professor A. H. Blanchard, of Columbia University, New York, recently delivered illustrated lectures at the University of West Virginia on the subjects, "Park Boulevards," "Bituminous Surfaces and Bituminous Pavements," "Wood Block and Stone Block Pavements," and "Modern Developments in Highway Engineering in Europe."



Before After

" Before and After " the application of Bay State Brick and Cement Coating.

Artistic Treatment of Cement Surfaces

The accompanying views illustrate very clearly the outward and visible possibilities of Bay State Brick and Cement Coating, manufactured by Messrs. Wadsworth, Howland & Company, Inc., 64 Washington street, Boston, Mass. This firm has solved the problem of producing a compound which when applied to cement gives a durable, pleasing exterior finish without showing a painted effect, and which at the same time is unaffected by dampness or alkali action. By practical demonstration the company found that the base of their compound must be of a concrete nature. The only medium suitable to such a base is one which does not contain an oil, which is affected by alkali, and one which will evaporate immediately and entirely upon application, leaving the base of the coating an integral part of the surface, and not as a skin coating like ordinary paint. Bay State coating is made in many pleasing tints and has a wide range of application.

Trade Notes and Miscellany

The seventh Chicago Cement Show which was held from February 12 to February 21 was very successful in every respect. The exhibits of cement and concrete materials were particularly good, and attracted engineers and contractors in considerable numbers.

The recently-incorporated Northern Electric Company, Limited, has taken over the Northern Electric and Manufacturing Company, Limited, and the Imperial Wire and Cable Company, Limited. The business previously carried on by the two latter companies will be conducted by the newly-organized company without change in management.

Nearly four hundred concrete-road builders, engineers and cement representatives attended the First National Conference of concrete-road building in Chicago from February 12 to February 14. Interesting papers were read dealing with the various phases of road building. The lively discussions which followed indicated the great interest taken in the subject.

Catalogue No. 26 issued by the Northern Engineering Works, Detroit, Mich., illuminates and describes electric and hand power travelling cranes, electric and pneumatic hoists, overhead track systems, bucket handling cranes and railway cranes manufactured by this company. The Canadian works of the firm are at Walkerville, Ont., where every facility is provided for handling crane work from the lightest character to the heaviest. The many large and important installations shown in the catalogue attest the reputation of the firm's products.

More than one leading Canadian firm took advantage of the inauguration of the new Parcel Post in Canada, but probably none made so much of the opportunity as The Pedlar People of Oshawa, manufacturers of all kinds of sheet metal products. On the opening date they dispatched to the leading architects, contractors, builders and jobbers throughout Canada, a large number of sample pieces of Pedlar's Square Conductor Pipe. This pipe fits admirably to any style of architecture and is so heavily galvanized as to be unaffected by moisture. Owing to its peculiar construction it will not burst through freezing.

An illustrated descriptive catalogue of the excavating machinery placed upon the market by Messrs. Pawling & Harnischfeger Company, of Milwaukee, Wis., will be of interest to contractors and others who recognize the urgent need of a cheaper method of taking out earth. The machines are described as being of the highest workmanship and combining therewith unusual simplicity and ease in operation. "P. & H." machines are built in various sizes to meet the requirements of different classes of work. The pamphlet is fully informative, containing detailed specifications of the equipment and a full list of sizes and approximate weights. The illustrations are illuminating as to some of the applications of these excavators.

Bond in Brick Work

"Bonds and Mortars in the Wall of Brick," is the title of an attractively-illustrated, informative book received from the Hydraulic-Press Brick Company, makers and distributers of Hy-tex face brick, St. Louis, Mo. The object of the book —and it is admirably fulfilled—is to show the artistic possibilities of the material bound up in the workmanship. It is pointed out that design in brickwork is based upon an accurate knowledge of the mechanical processes of the bond. Especial care is taken to differentiate between bond and pattern. From the same company we have received a copy of "Brick Scale Tables," with explanatory notes for the designer in brickwork. These tables, as well as the booklet "Bonds and Mortars," are designed to eliminate the laborious detail incidental to the preparation of drawings for a brick structure. Too often the designer has been deterred from the use of an otherwise very desirable bond and pattern by the real difficulties that lie in adjusting the brick units to the wall dimensions, and has thus lost one of the finest and subtlest artistic effects which legitimately come within the range of his profession.

The Hydraulic-Press Brick Company are known as the largest makers of face brick in the world. They have fourteen offices and twenty-three manufacturing plants distributed throughout the world.

Making the Truck Pay

By H. D. Pratt, Engineer, Link-Belt Company.

THE motor truck has come to stay. Its ability to carry bulk material long distances in quantities unheard of ten years ago, and at a high rate of speed, makes it possible to materially reduce the cost of transporting large quantities of stone, coal, sand, gravel, etc. The speed of travel is high as compared with the horse-drawn vehicle. The unloading is automatic, the body being dumped by the mere turn of a lever by the truck operator. In many cases the truck is loaded from an overhead chute, but more often the material to be moved lies on the ground in storage piles, not only in regular storage yards, but in streets, roads and wherever most convenient to store. The loading of this material from ground storage piles becomes a different matter. The high cost of loading auto trucks with material carried on ground storage is one of the factors which have retarded the sale of trucks for this work.

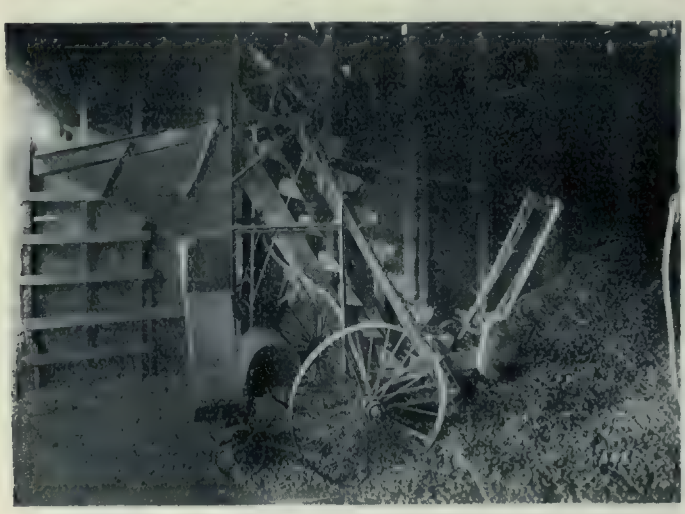


Fig. 1.—Portable wagon and truck loader.

The truck which is so quick and convenient for handling several tons at a load, must necessarily be high to hold the load. Shovelling by hand means that the truck spends more than half its time waiting at the storage pile to be loaded, and between trucks the shovelling gang is idle. A good average day's work for a shoveller is 20 tons of gravel, less of stone, and slightly more of sand. Not only is the truck standing idle while being loaded, but the loading by hand costs 8 to 12 cents a ton. Here is a bad leak in what should be an up-to-date and efficient job of handling.

The portable wagon and truck loaders effectively stop this leak. Fig. 1 shows how. A bucket elevator is mounted on large wheels, and with power supplied by a motor or gasoline engine, will load sand, gravel or coal at the rate of a ton a minute. The truck driver trims the truck with a shovel, and one, two or three men, depending on the nature of the material to be handled, trim and feed to the loader. This combination will load the truck at a cost of 2½ cents to 5 cents per ton, the higher cost being that of handling crushed stone, with coal at the low end, and sand and gravel following in order. The saving of about 6 cents per ton thus effected is a large item in these days of close margins and competition, and marks the loader as a useful and necessary adjunct of the motor truck.

There is also a growing demand for a further combination of truck and loader, namely, a truck with loader elevator mounted on the rear end of the body, arranged to lower into a storage pile when the truck is backed up to it, and also to raise clear of the ground when not in use. The elevator is supported independently of the dumping body, and is driven, through a clutch, by a connection to the truck transmission. This combination results in a truck which can be loaded by its driver with or without a helper in a few minutes, and does away entirely with the necessity for a loader-operator who is idle between trucks.

The loaders described above are made by the Link-Belt Company, Philadelphia and Chicago.

A concise, attractive catalogue received from Messrs. Canadian Billings & Spencer, Limited, Welland, Ont., shows details of wrenches and machine goods made by this firm and contains an enumeration and description of the other goods manufactured. The business of this concern has developed rapidly since its inauguration in 1907 and this catalogue, the first issued by the company, is of much interest. The various tools are carefully illustrated, concisely described and indexed, and the booklet constitutes a ready reference to the firm's products. In order to finish their forgings to meet the requirements of their customers, the company have installed a powerful electric welding machine which enables them to undertake all manner of electric welding. The equipment of the plant includes bull-dozing and heading machinery.

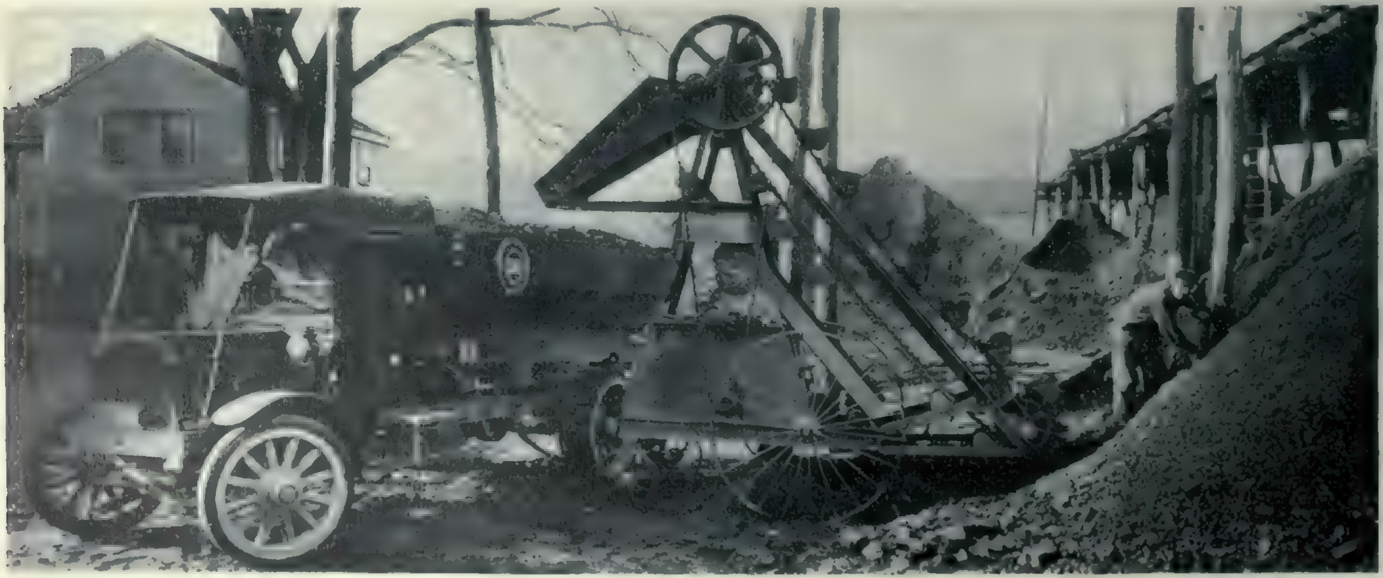


Fig. 2.—Portable wagon and truck loader in operation.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **March 11, 1914** **No. 10**

Principal Contents

Unsavory Contract Procedure ... 285
Engineers' Estimates in Contracts ... 285
Are Engineering Prospects Improving? ... 286
Should Engineers Describe their Failures? ... 286
Substructural Bridge Work by Pneumatic Method.. 287-293
Municipal Sliding ... 293
Mouthpiece for Suction Dredges ... 293
Progress, Design and Construction of the new Welland Canal ... 294-298
(Staff Article)
Requirements and Scope of the Consulting Engineer in Waterworks Practice ... 299-301
Reinforced Concrete Bridge at St. Catharines, Ont. ... 302
(Staff Article)
Engineering Topics in the Old Land ... 303
(London Correspondence)
A Practical Discussion of Estimating Methods in Building Work ... 304
By Henry A. Hoyt
Hydraulic Dredge for Arrow Lakes, B.C. ... 305
Structural Features of the McLeod Bldg., Edmonton.. 306
Mixing and Placing Materials for Concrete Roads ... 307
Canadian National Association of Builders' Exchanges Report of the Annual Convention of the Western Section ... 309
Montreal Water Conduit—Experts' Findings and Recommendations ... 310
Personal Mention ... 311
Constructional, Railroad and Industrial News ... 312-314

Unsavory Contract Procedure

WE hear that a section of the contracting community of London, Eng., is indignant over the action of the Borough Council of Bermondsey, a suburb of the metropolis, in permitting the lowest bidder for a certain building to amend his tender to the extent of some five hundred dollars. Such conduct on the part of a public body is severely condemned, it being held that such a policy is likely to destroy the faith of contractors in public tendering.

The defence is that the accepted tender was a great deal lower than the next bid and that the authority did not desire to take advantage of an obvious mistake.

We have little part in local contracting procedure in England, but we cannot refrain from commenting briefly upon this practice as illustrating something to be avoided in Canada, more particularly since it is generally contended that the ethics of contracting in England occupy a higher plane than on this side of the water.

Tendering is largely speculative, and as such it can never be wholly above suspicion; but any recognition of this on the part of authorities—any latitude which admits of such an easy resort as tampering with bids after they have been sent in, should be strictly tabooed. We do not hold for one moment that an authority should have no power of discrimination in the matter of releasing a man from his bid; because, obviously, it would be poor policy to hold him to an inordinately low figure and run the risk of an inferior job, scamped workmanship, or fraud in some other guise. What we contend is that a substantial claim to unwitting error once established the award should pass to the next lowest bidder—in other words, "the lowest bidder but one."

Some years ago, by the way, the London Correspondent of this journal, whose letter is published in another column, came forward with a suggestion that contracts should be awarded, not to the lowest bidder, but to the lowest bidder but one. The case that has arisen at Bermondsey would appear to be an argument in favor of putting this suggestion into effect.

Certainly it is an outrage upon those who play the game in good faith to allow any addition or subtraction once the hands have been shown.

Engineers' Estimates in Contracts

THE relation between contractors on the one side and municipalities and their engineers on the other is one which has of late years received considerable attention; but there is still much to be done before these relations will have reached the point where they are fair to all parties and adapted to securing the best results. There is still a tendency on the part of the city to consider the contractor as more or less of a highwayman with whom it is unfortunately necessary to have occasional dealings; and there are still engineers not possessed of that judicial spirit with which they should undertake the functions of unprejudiced arbitrator with which they are endowed by most contracts, says the Municipal Journal.

One point in which it is claimed the engineers are unfair to the contractors in many cases is that of the engineers' estimates of quantities and costs—either by not giving them or by an unfair use of them. In fact, a prominent contractor calls attention to the custom of asking for a lump bid for a piece of work for which the plans and specifications are submitted but requiring the contractor to figure out the quantities himself. This, he states, is unfair to the contractor, as an error on his part in figuring out the quantities would either cause his bid to be too high and thus deprive him of the contract, or else it would be too low and cause him to lose money on the work. Moreover, he believes that it would contribute to collusion between contractors, in that they would naturally compare notes as to quantities and thus open the way to a "gentlemen's agreement" as to prices, to the disadvantage of the city. In most cases the engineer has already calculated the quantities, and there would seem to be no good reason why he should not state them.

The more common method (in this country, at least) is for the engineer to state the estimated quantities of each item and compare the bids on the basis of such quantities. It is generally provided, however, that these quantities may be increased or decreased during the construction of the work, and in the majority of contracts no limit is placed to such change. Ordinarily little exception can be taken to this method, since it must be realized that in most work it is impossible to fix beforehand the exact quantities of each item necessary to complete the work. Contractors have complained, however, that this clause permits altogether too much freedom to the city, and that a certain item could be increased not only five or ten per cent., but ten-fold or more, or could be similarly diminished in quantity. Thus, for instance, a contractor might assemble on the ground an expensive equipment for removing rock from water pipe trenches, only to have the city decide after the work was begun to alter the route of the trench so as to avoid rock cutting altogether, in which case the contractor gets no return for extensive rock work. It would seem only just to the contractor to set a limit to the amount by which the quantity of any item could be increased or decreased; and then, if it is necessary to exceed this limit, to have the additional amount come under the head of special work, the allowance for which is to be agreed upon by mutual consent or arbitration, or by prices or allowances fixed in the contract.

Are Engineering Prospects Improving?

During the last few years the history of engineering appointments in Canada has been anything but encouraging, and upon more than one occasion we have felt constrained to write in a pessimistic vein concerning the prospects offered by the profession under existing conditions; so that having obtained a like consolation from a perusal of some editorial observations on the part of the Engineering Record we are only too pleased to preserve the essence of that journal's sentiments. The Engineering Record finds that the average engineer is better paid than members of the clerical, legal and medical professions and considers that the outlook is steadily growing better. We quote our contemporary:

"Good salaries are more and more likely to come to competent men as the public realizes more and more the importance of their services from the standpoint of sheer economy, if nothing better. Still greater cause for encouragement is to be found in the demand for men of first-class engineering training in responsible executive positions. Mr. Waite, the city manager of Dayton, is a good example of the kind of fortune that is more and more likely to come the engineer's way. With the present trend of business such opportunities are sure to develop more frequently. The whole engineering profession, for example, should have rejoiced when one of their brotherhood found his way to the head of the biggest electrical company in the country. Every large enterprise in the future will have to depend on a high grade of technical ability in executive positions. High finance is somewhat less popular than it was, and the plain stockholders are beginning to look about for men of tried ability to take the place of clever jugglers of securities. The spell is beginning to work, although slowly, and unless all signs go awry the next decade will see many big concerns getting down to first principles and depending on men who know how to do things superlatively well in their own lines of activity. Engineering, therefore, is going to look up instead of down, and the men who are now showing their capacity in minor positions have a better chance than ever of finding their reward."

Should Engineers Describe Their Failures?

Once more our Chicago contemporary, Engineering and Contracting, returns to a discussion of this subject upon which we commented in our issue of January 21 under the heading "My Greatest Mistake." Taking issue with us in our contention that the idea was all right in theory, but that it was impracticable and that few members of the engineering profession would survive any publicity given to their greatest mistakes, our contemporary makes out such an excellent case that we are only too pleased to quote the pith of the arguments adduced:

"To illustrate the character of failure which we had in mind let us assume that an engineer designs a concrete dam along well recognized lines for the greater part but differing somewhat from other dams in some important detail, for example, in the design of the flood gates. Let us suppose, also, that the design of the gate adopted seems to give promise of doing good service, and of possessing certain advantages over older types. Again, suppose that the designer describes his design in an article contributed to some technical journal and calls particular attention to the flood gate by illustrations and descriptive matter. Now our point was that should the gate prove deficient when put to the test the designer should give the same publicity to that fact that he gave to the first statement of what he believed his design would accomplish. We cannot think that our suggestion is impracticable or that its adoption would injure the reputation of the designer among thinking men who realize that mistakes of this nature are being made frequently and by everybody who does much work.

"Our contemporary* uses in an illustration of its views of the broader aspect of the description of engineering failures a reference to making a "mess" of the engineering for a city's water supply. A failure which can be characterized as a "mess" is usually described by others and unless the designer desires especially to state his side of the case there is little left for him to say. Moreover, "messes" of engineering work need no longer be made by those who will take the trouble to become well grounded in such fundamentals as the text-books set forth. If an engineer makes a failure of a system of pipe sewers it can have but slight interest to the profession as a whole, for thousands of engineers are now entirely competent to carry such works to a successful completion. But if an engineer tries out a new type of sewage tank and it fails his reputation will not suffer from a recital of his apparently sound reason for adopting the design and a statement of the tank's failure to accomplish the results desired."

---

* Contract Record.

Substructural Bridge Work by the Pneumatic Method

DURING the last few years the substructures of a number of important bridges have been built by the pneumatic method, the reasons for the adoption of which in a number of noteworthy cases are explained in this article. At the outset, reference may be made to an article relating to the substructure of the new C. P. R. bridge over the Red River, published in our issue of January 21, and to the article on the Mud Lake bridge in our issue of January 28. The data here given are in part supplementary to the descriptive matter contained in the above-mentioned articles, but the introductory portion is an entirely original feature, several new structures are described and the whole is illustrated with illustrations furnished expressly for this journal. The article is abstracted from a paper given last month by Mr. John W. Doty, Vice-President and General Manager, Foundation Company, Limited, Montreal, before a general section meeting of the Canadian Society of Civil Engineers.

General view of the bridge under construction at Harrison Mills, B. C. For general elevation of this bridge see Fig. 3, page 288, and for description see page 291.

The Pneumatic Method

During the past few years the following bridge substructures have been constructed by this method: two bridges over the Red River at Winnipeg; bridge over the St. Lawrence River near Lachine; bridge over the Harrison River at Harrison Mills, B.C.; bridge over the St. Lawrence River near Quebec; bridge over Mud Lake, near Perth, Ont.

The pneumatic method has been developed to meet treacherous water and soil conditions, and to insure the founding of a structure on a suitable, properly prepared bottom in the shortest possible time and for the minimum cost considering the conditions encountered. It is naturally the most expensive method of construction, but it is possible to build the structure where all other methods would fail.

To emphasize the importance of this method it might be well to classify foundations in general in the order of their relative cost, provided, however, conditions are favorable for the use of the class or type selected. Class 1.—Spread footings. Class 2.—Piles. Class 3.—Piers constructed by the open method. Class 4.—Piers constructed by pneumatic method. Class 5.—Piers constructed by a combination of Classes 3 and 4.

Foundations under Class 1, spread footings, are usually placed on the soil a few feet below the ground level. This class of foundation may be subdivided into the following types:—timber grillages; concrete footings; reinforced concrete footings; steel grillages imbedded in concrete.

Foundations under Class 2, pile structures, are generally used where the material at the bottom of the footing is not capable of supporting the load and it becomes necessary to drive piles to some better strata of material in order to obtain a safe support. This class of foundation may be subdivided into the following types:—sand piles; wooden piles; concrete piles moulded in the ground; concrete piles built up, seasoned and then placed; steel tubular piles driven and filled with concrete.

Class 3, piers constructed by open method. These foundations are usually carried a considerable depth below the general ground level to hardpan or rock, and can be subdivided into the following types:—timber sheet pile constructed cofferdam; steel sheet pile constructed cofferdam; timber or steel boxes built up and sunk as excavation is made; timber-lined construction, or where the sides of the excavation are

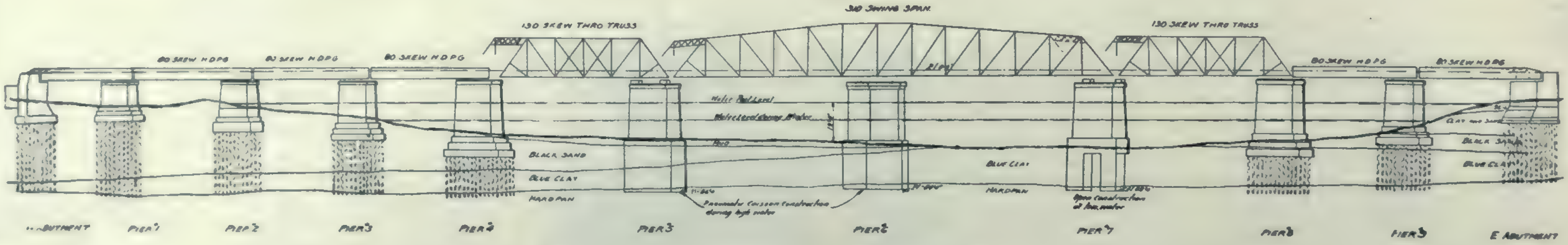


Fig. 1—General elevation Red River bridge No. 2.

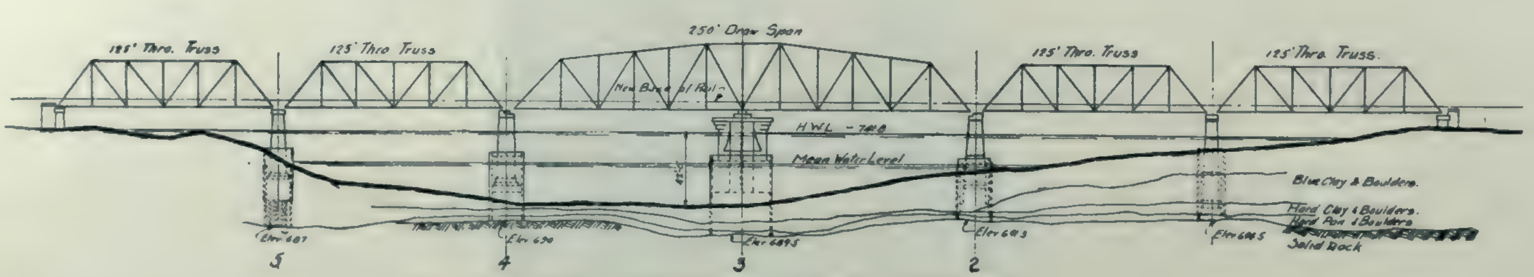


Fig. 2—General elevation Red River bridge No. 1.

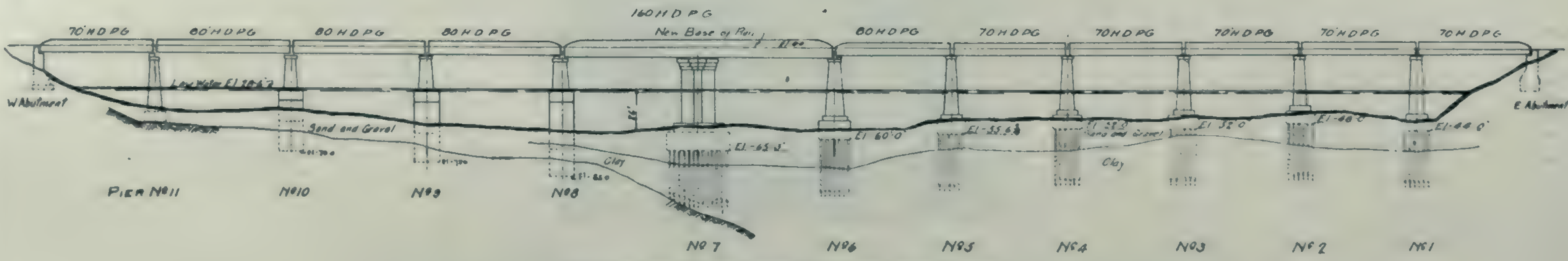


Fig. 3—General elevation Harrison River bridge.

lined with timber as the excavation is made; caissons built and filled with concrete before sinking; monolithic concrete caissons which are moulded before sinking.

Class 4, piers constructed by pneumatic method, are usually carried a considerable depth below the general level of hardpan or rock, but the limit of depth to which this method is practical is 100 feet below water level. This method can be divided into the following types:—caissons built of timber or steel filled with concrete before sinking; monolithic concrete caissons which are moulded before sinking.

Class 5, piers constructed by a combination of Classes 3 and 4. The two last types of Class 3 referred to can be readily commenced by the open method and completed by the pneumatic method.

The principal conditions governing the selection of the class and type of any foundation for any particular purpose are as follows:—(1) the magnitude and distribution of the loads to be supported; (2) the nature of the soil on the proposed site; (3) the depth to rock or to suitable bearing material below the water level; (4) the elevation of water level; (5) the value of the structure to be supported; (6) the surrounding conditions, such as adjoining structures; (7) speed of completion; (8) the possibility of the disturbance of the material in which the foundation is resting; (9) the economy of construction.

The type of foundation selected for any particular purpose should be the one that safely fulfils all the above conditions and is the cheapest to construct.

The importance of the foundations for structures makes it imperative that the engineer should take a conservative attitude in selecting the type to be used. Time limits the discussion in detail of the advantages and disadvantages of each particular type of foundation. However, it might be well to note the reasons for the failures of some of these types.

Class 1.—Overloading the soil.
Placing footings on a soil overlying a soil of lesser bearing value.
Designing eccentric footings and not taking into consideration the maximum pressure due to the load not being evenly distributed.
Designing reinforced concrete footings on the assumption that the pressure will act uniformly on the soil, no allowance being made for the lack of uniformity of the soil.
Placing heavy loads on reinforced concrete footings where they are extended below the water level.
Not carrying footings deep enough to prevent frost action.
Not carrying footings deep enough to prevent undermining by scour.
Not carrying the footing deep enough to provide protection against the material under the footing being disturbed by adjoining construction operations.

Class 2.—Wooden piles which have not been driven to a firm underlying stratum or driven to a sufficient penetration.
Wooden piles which are overdriven and broken.
Where a great many piles are driven at close centres it is, in many cases, impossible to drive all the piles to a firm stratum on account of compressing the upper strata. A readjustment of the soil might take place and permit the structure to settle, as all the piles were not driven to a firm underlying stratum.
A steel tubular pile is as a rule overloaded and no allowances made for the reduced bearing value when the exposed steel has deteriorated, also due to the impracticability of founding the bottom of the pipe on a material capable of supporting the usual overload.

Class 3.—Failure of this class usually occurs when the foundations have not been founded on a suitable bottom, due to the impossibility of properly cleaning it off on account of the large quantities of water which are encountered.
Failures due not to the completed foundation themselves but to the fact that the method of construction would not prevent the flow of material which will probably cause damage to the adjoining property, especially if the water or soil conditions are treacherous.
Failure or the impracticability of constructing this type of foundation where large quantities of water are encountered, or the nature of the soil is such that the action of the water on the soil will cause it to flow, making the conditions impossible to reach the assumed bearing elevation.

Class 4.—Failures in this class are due only to poor workmanship or unavoidable accidents, but these, with the present day methods, are very improbable.

From the above data it will be noted that the pneumatic method is classified as the most expensive, but one that overcomes the difficulties in reaching a suitable footing and permits the proper preparation of the bottom on which to found the structure, and the construction below adjoining structures where water and soil conditions are serious, without damage to the adjoining structures.

The pneumatic method has developed during the last fifty or sixty years with the advent of the heavy and expensive structures. It might be of interest to note that this method is derived from the principles used in the diving bell. This appliance was conceived by the ancient Greeks, developed and used in America for the first time on bridge substructure work about the year 1860, the present method having been worked out during the last fifty years.

It might be of interest to explain briefly the principles of this method. A pneumatic pier usually consists of three parts, the working chamber, the shaft and the cofferdam. To this structure should be added the equipment necessary to control the air pressure, which is the air shaft, air lock and air supply pipe line. The working chamber can be explained as an inverted box with an open bottom, on which is placed a portion of the concrete shaft, and extending above and around the perimeter of this concrete shaft is the cofferdam. The steel air shafting is built into the concrete shaft and connects the working chamber with the air lock. The working chamber, air shaft and air lock are designed to withstand safely pressures of at least 50 lbs. per square inch, which is the practical limit of the pneumatic method.

The air lock consists of a shell with two diaphram plates to which are suspended two doors. These doors permit the passing of men and materials from the atmospheric pressure to the increased pressure in the working chamber without allowing any appreciable decrease of the higher air pressures in the working chamber. In addition to the equipment on each caisson, it is necessary to operate an air compressor plant.

The above outline gives the principle of the method and equipment for operation, and shows the reason for the expense in constructing work by this method.

Red River Bridge No. 2

The first work to be discussed is the construction of the piers for Red River Bridge No. 2, at Winnipeg. Fig. 1 gives the elevation of the bridge, showing the depth of water and the depth to rock, also the nature of material on the site overlying the rock. In general, the water in the river is approximately 28 feet in depth, while the rock is about 62 feet below water level. The soil overlying the rock varies from a stiff clay on the east bank to a fine flowing sand on the west bank, and in certain places both of these materials were found in different strata. Generally speaking, the soil in and about Winnipeg flows or is displaced by surcharged load or vibration, and although some clays might be loaded safely on the basis of two tons per square foot, the use of spread footings would be impracticable for a heavy or expensive structure, especially where vibration due to rolling stock would aggravate the conditions. Also on account of the general movement of the soil in this vicinity it is not possible to put a structure of this type on a spread footing at any cost.

Considering Class 2 or pile type of foundations, these were adopted for the two abutments and piers 2, 3, 4, 8 and 9, which supported the flanking or fixed spans; but on account of the nature of the material and the general movement which has been referred to, it was deemed inadvisable to use this type on piers 5, 6 and 7, which supports the drawspan, and would cause trouble and inconvenience if any settlement or movement took place, whereas on the flanking piers a slight movement or settlement would not seriously affect the structure. For this reason it was decided to carry piers 5, 6 and 7 to hardpan or rock, which borings indicated would be encountered at a depth of 65 feet below water level, eliminating Classes 1 and 2.

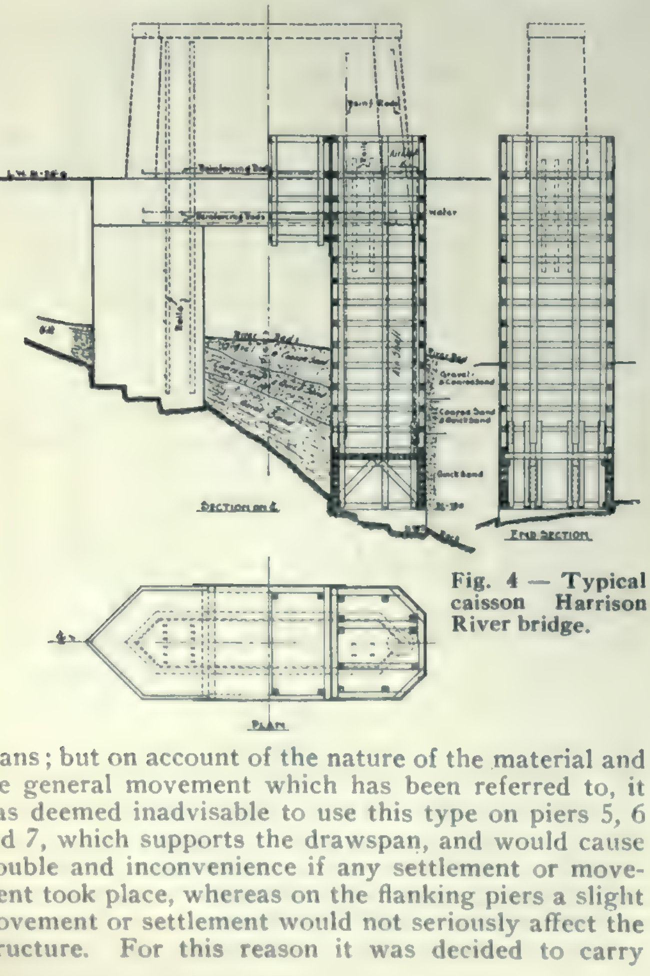


Fig. 4 — Typical caisson Harrison River bridge.

Class 3, dredging types, were considered inadvisable on account of the stiff clay and sand strata which were encountered at the site of these piers. Stiff clay is a material which cannot be economically excavated from the inside of a box through any great depth of water. It was inadvisable to use the open cofferdam type and excavate in the open, on account of the numerous water bearing sand strata which were encountered at depths which were not economical for unwatering. Also because of the necessity of founding the piers on a uniformly hard bottom in the hardpan and at such depths below water level, it was impracticable to pump out the cofferdam in order to make this excavation in the open, and dredging this nature of material through the water at such depths is expensive and unreliable.

Another item which had to be taken into consideration was the time allowed to complete this structure. The plans were approved by the Government on December 28th and it was necessary that this structure be completed not later than September 1st, and an open method, if possible, with its numerous contingencies with this depth of water would be uncertain and date of completion not positive.

In conclusion, the reason for the adoption of the pneumatic method on this work was:—(1) the loads to be supported; (2) the vibrating load to be supported; (3) the elimination of any possible settlement or movement which might interfere with the operation of the drawspan, necessitating the pier being founded on good uniform hardpan or rock; (4) the impracticability of dredging or excavating the clays to hardpan through the water by any economical method; (5) the impracticability of unwatering; (6) the speed necessary in order to insure completion.

Pier No. 6 was the largest and last pier constructed. The working chamber was built on the shore and placed on the site on the 25th of June, 1913. It was bottomed by the 19th of August. This pier, which contained 3,192 cubic yards of concrete, was completed in 55 days from the date the caisson was placed on the site. The total substructure was completed by August 28th, or within eight month's time.

Pier No. 5 was constructed by the pneumatic method at high water period. Pier No. 7 was constructed by open method at low water period. It required twice the length of time as pier No. 5 and was considerably more expensive.

Red River Bridge No. 1

Fig. 2 shows the elevation of this bridge, the depth of water, the distance to rock, and the nature of material on the site overlying the rock. This structure is within three miles of the bridge known as Red River Bridge No. 2, and the general conditions are similar, except that the clay does not contain layers of sand as at the site of Red River Bridge No. 2. The work consisted of extending the piers of the old bridge for the purpose of double tracking. The old piers were constructed by the dredging method some years ago, and the substructure required approximately two years to complete.

The old piers were all carried to hardpan by the open dredging method, except pier No. 5, which was founded on piles. The reason for founding this pier on piles was on account of the impracticability of carrying the same to hardpan or rock by the open method because of the material flowing into the caisson as the excavation was being made, and the impossibility of making progress in excavation sufficient to overcome the inflow.

The extension to piers No. 1 and 2 was built by the wooden sheet pile method (Class 3), which was practical on account of the stiffness and previous nature of the day. The extension to pier No. 5 was founded on piles. The excavations were made to the elevation of the old footing by the use of the steel sheet pile cofferdams.

Old piers Nos. 3 and 4 were founded on hardpan by an open dredging method and the concrete was deposited through the water. The probability was that some slight settlement had taken place during the past years, but had come to rest, and the only safe manner of insuring against even a slight settlement of the new portion of the piers when combined with the old was to carry the new portion of the piers to rock. This necessitated excavating several feet below the footings of the old piers, and to make this excavation economically, considering both the nature of the material and the absolute necessity of not disturbing the hardpan under the old portion of the pier, the pneumatic method was used.

As stated above, it required about two years to complete the substructure of the first portion of the bridge, whereas the extension of the piers had to be completed in less than seven months. The contract for this work was awarded in February, and the construction was all completed by August.

In reference to the use of the pneumatic method on the double tracking of the St. Lawrence River Bridge, this plan and method was used for the extension of the piers. The conditions existing and the means of overcoming the difficulties were similar to those found and overcome on the Red River Bridge No. 1. A number of the old piers of this bridge were founded on rock but a great many were resting on hardpan, and to eliminate any possible splitting of the piers when the old piers and the extension were bonded together, the extensions of all the piers were carried to rock. In one case it was necessary to carry them to a depth of 9 feet below the footing of the old pier. The greatest depth of water was 42 feet and the maximum current approximately 9 miles per hour.

Harrison Mills Bridge

This work is now under construction over the Harrison River, at Harrison Mills, B.C. Fig. 3 gives the elevation of the proposed structure, the depth of water to rock, and the nature of soil overlying the rock.

The soil being principally sand and gravel, with a little clay on the east portion of the bridge, it was deemed practical to build the eastern half of the bridge on wooden pile foundations, and the western portion of the bridge on rock by the use of the open caisson method on account of the shallow depth of the rock. Additional borings made on the site after the work was begun showed that the rock on the western portion of the bridge sloped at an angle of from 30 to 40 degrees.

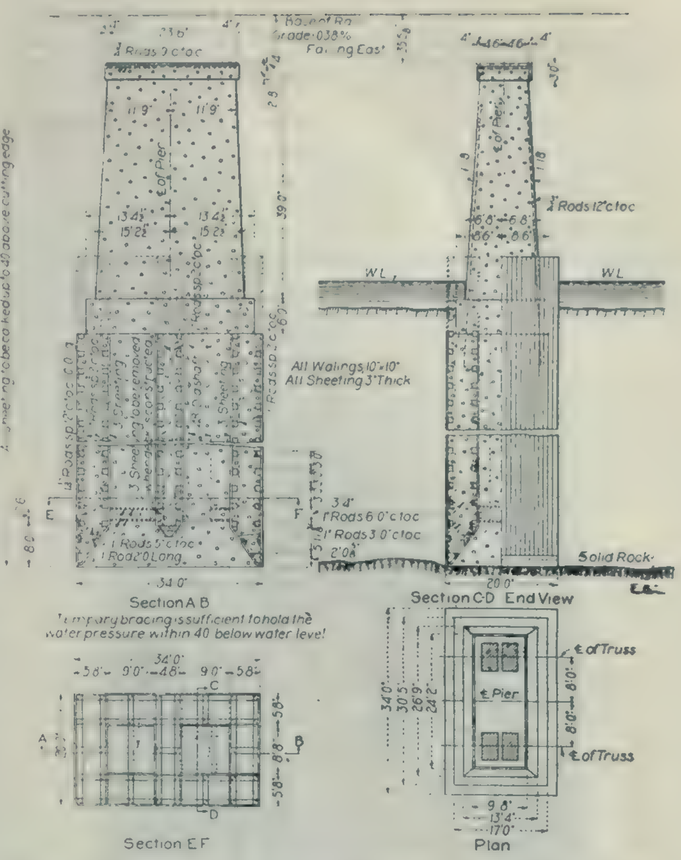


Fig. 6—Plan and sections of caisson and dimensions of pier No. 2, Mud Lake bridge.

On pier No. 8 (Fig. 4), the depth of water was approximately 25 feet, the depth to rock on the downstream side of the pier was 30 feet, and the depth to rock on the upstream end of the pier 55 feet. The soil overlying the rock was principally sand and gravel with traces of clay. It was necessary to carry the footing of the pier into the river bottom at least 8 feet to protect the pier against scour. This depth would bring the downstream end of the pier on rock, whereas the upstream end would be approximately 25 ft. from rock. It was not practical to use a spread footing class of foundation as one end of the pier would be resting on rock and the other end on sand, gravel and clay, which would no doubt settle and cause it to slip out of line. It was also not practical to consider the use of piles on account of the short length of these at the downstream end of the pier. It was also not possible to construct an open dredging caisson in one mass at the

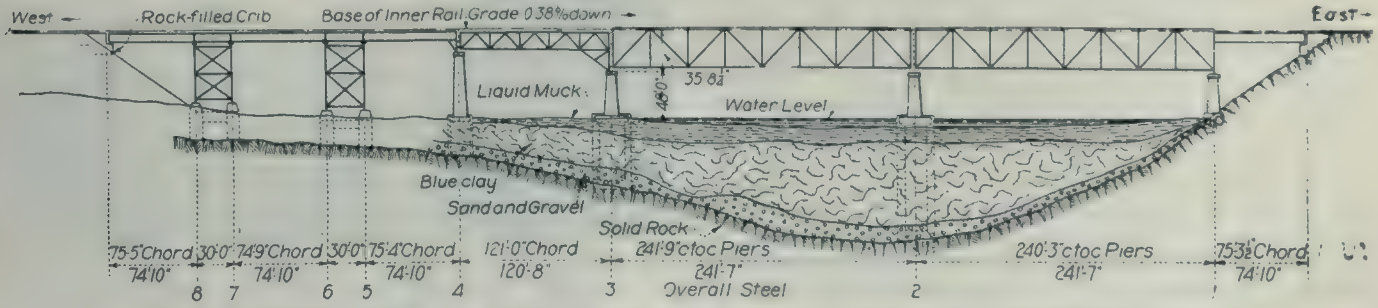
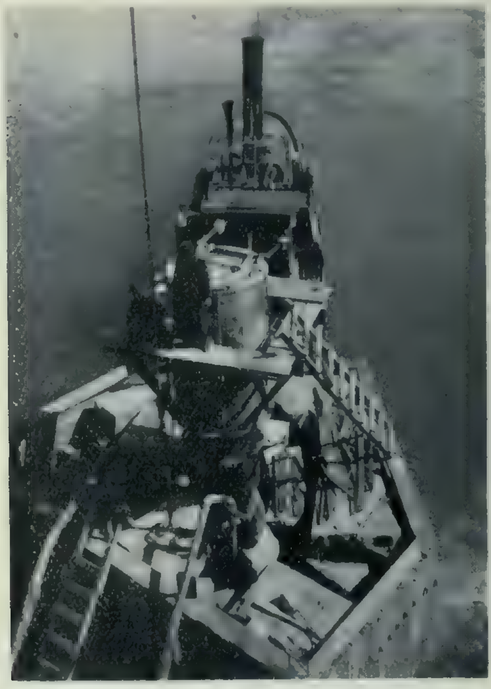


Fig. 5 –Elevation of bridge over Mud Lake, Ont.. showing type of construction and character of subsoil.

site of this pier, because of the steep slope of the rock and the large expense to be incurred if the rock was excavated sufficiently to enable the caisson to be carried to a uniform rock level.

For these reasons it was finally decided to found the pier on rock, using either an open method or pneumatic caisson on the downstream or shallow end and a pneumatic caisson, on account of the depth of the water, on the upstream end of the pier, the rock being stepped off in the working chamber so as to prevent sliding. It was also decided that the concrete shaft of the pier should be built on these two independent caissons, the shaft to extend to a depth of approximately six feet below low water to the coping, the whole design being reinforced so as to combine the two caissons, and the shaft to take up all strains to which this type of pier would naturally be subjected. This design and method of construction is being used on piers Nos. 8, 9 and 10.



Pneumatic caisson, St. Lawrence River bridge.

The Quebec Bridge

On account of the magnitude of this structure it was necessary to found the piers on a stratum which would absolutely preclude the possibility of settlement, and to carry the footings to such a depth as to eliminate any possibility of scour.

The nature of the material on the south pier was such that pneumatic caissons could be founded on rock at an elevation of approximately 85 feet below the water level, and it was necessary to use this method in order to excavate to rock and properly prepare the rock surface. The north pier was founded on hardpan at a depth of approximately 60 feet below the water level. It was necessary in either case, in order to reach the stratum on which the piers were founded, to do the work by the pneumatic method as it was impracticable to remove the large boulders and other material by any dredging method, and when the hardpan or rock was reached, this bottom had to be prepared in such a manner as to preclude any possibility of settlement.

In the north pier, which did not reach rock, the engineers carried on an exhaustive test on the soil before permitting any concrete to be placed.

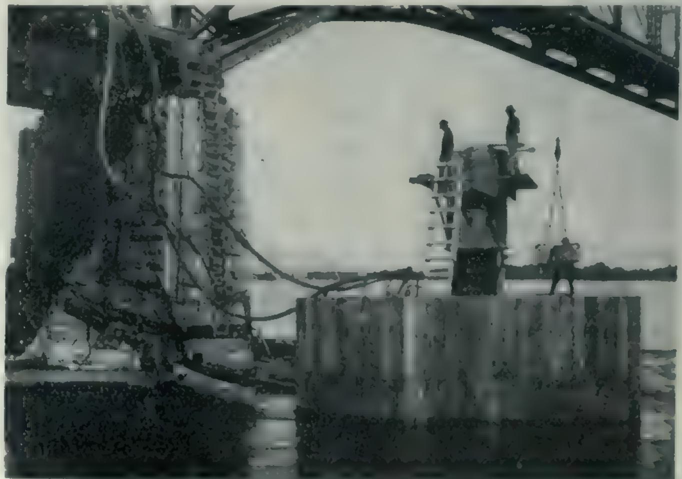
Mud Lake Bridge

Fig. 5 gives the elevation of the bridge over Mud Lake, near Perth, Ontario. It also shows the depth of water, the depth to rock and the nature of the material on the site overlying the rock. The conditions on this site are rather unique in many ways. At the site of pier No. 2 (Fig. 6) the water is about 8 feet in depth, but for the next 50 feet the material is a liquid clay. Below this liquid clay is encountered a stratum of stiff clay to a depth of 12 feet, under this is a stratum of boulders, sand and clay, which is very firm and compact and below this stratum, and overlying the rock to a depth of about 10 feet, is a stratum of cemented sand, rock being encountered at the site of this pier at a depth of from 108 to 115 feet.

It is quite obvious that a spread footing design foundation would not support the load. A pile type of construction would be inadvisable on account of the great depth of liquid mud which would not give the piles lateral stability, the small amount of penetration which the piles would obtain in the stiffer underlying stratum of clay, and the probability that the piles could only be driven to the stratum of boulders and no further. The constant vibration and the stresses due to traction would so affect the foundation that the lateral stresses could not be resisted by the upper portion of piles in the liquid clay, and the working or slight movement which the vibration would cause in the foundation would soon affect the soil adjoining the piles in the stiff clay stratum and cause it to soften.

In the liquid clap mass encountered on this site there is no assurance that the whole mass is not following some progressive movement, which might be slight but in years to come might move any structure which did not receive its support from some underlying fixed surface which would preclude the possibility of movement. The pier should be so designed that in case of a movement of this nature it would be strong enough to resist it and to permit the material to flow around it. For this reason it was deemed inadvisable to place the foundations of this structure on any substance other than a material equivalent to hardpan, or, if possible, on rock.

An open caisson type could be carried to the stiff clays, but this type is impracticable in stiff clays at this depth on account of the great troubles encountered in dredging and removing it. The boulder stratum below this stiff clay was not deemed of sufficient sta-



St. Lawrence River bridge. Sinking pneumatic caisson at pier 14. Note the rigging around the old pier for launching caisson.

bility for the support of this pier, and it would not be economical to remove this nature of material by an open dredging method. It was also deemed advisable to carry the pier some distance into the cemented sand, so as to be certain of obtaining a uniformly hard surface before placing concrete. It would be impracticable at this depth to do this by an open method. For these reasons it was finally decided to construct an open dredging pier and carry it into the stiff clay stratum, at which elevation the dredging caisson was converted into pneumatic caisson and carried through the stiff clay and boulder stratum into the cemented sand until a uniform surface was reached and properly prepared. To add greater stability to the pier the bottom was belled or carried out a distance of 18 inches beyond the perimeter of the caisson, and the whole lower portion concreted to form the base to support the pier. The excavation was carried to a depth of 103 feet 8 inches, which is the deepest bridge pier in Canada, and, with the exception of one, the deepest in America.

The contract for this work was awarded on December 28th, 1912, with the proviso that it should be completed by July 15th, 1913. On account of the delay in obtaining suitable materials before April 1st, active construction was not commenced before this date, and the bridge was completed ready for the superstructure on August 10th, 1913, or in four and a half months' time.

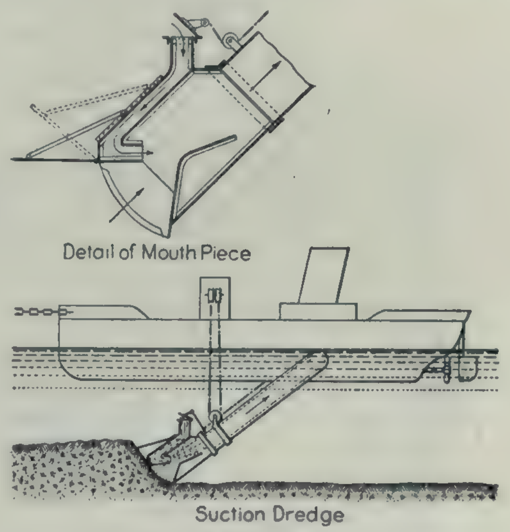
In conclusion, it is quite evident that the pneumatic method, although the most expensive one in the general classification of foundations, is the most economical, considering the conditions which were encountered in the above examples, and brings out clearly the certainty of securing a suitable footing beyond any doubt, the speed of completion and the positive manner in which difficulties can be overcome.

Municipal Sliding

CANADIAN people, says The Surveyor, of London, Eng., are eminently practical. Among their latest accomplishments is the provision of municipal skating rinks and toboggan slides. Vast possibilities are opened up by their introduction. Sliding and backsliding may now be indulged in by both councillors and officials, and an occasional cropper, while entailing possibly some momentarily loss of dignity, will have no injurious effect upon the moral reputation. That elusive member of committee who, blowing hot and cold in the same breath and hunting with hare and hounds, blows cool and steers a midway course when the Press are in the room, may now disport himself at will, turning and twisting and cutting intricate figures to his heart's content. Treading on thin ice will necessarily be avoided with care, although valour may occasionally outrun discretion when the surveyor is being harried into a dangerous corner by a municipal pack in full cry. Tobogganing, too, will have its attractions. On a sled of sufficient capacity the whole council will be enabled to slide in manner both unanimous and dignified, although, a team of horses would have to be employed for a similarly qualified backsliding. An official of evil disposition could possibly cajole his council to enterprise in a leaky toboggan fitted to a water-chute, his trouble being well repaid by the final splash. The switchback toboggan would specially commend itself as typical of public office, with its ups and downs (the downs preponderating), its joyous mountings to the empyrean followed speedily by its fearful descents to Avernus, its unexpected turns, its gradual slowing down, and its ultimate and complete stagnation. Certainly there is more in the idea than meets the eye at first sight.

Mouthpiece for Suction Dredges

A new type of suction-dredge mouthpiece without any rotating element has been patented in Germany by Herr Pieter von Wienen, of Hamburg. It has the shape of a square box, as shown in the accompanying drawing. Above the lower side is a bent plate forming a dam across the opening. In line with the back slope of this plate and above it is placed the inclined intake for water, this arrangement providing an efficient means for breaking up the dirt and giving a good mix. The amount of water is regulated from the dredge by a chain operating a flap valve at the pipe intake. An adjustable shield in the front of the box, supported on three struts running in guides and held in place by screws, serves to guide the material to the opening of the mouthpiece.



Mouthpiece for suction dredge.

The mineral production for 1913 in the Province of Quebec is the highest yet recorded, as we learn from a statement just issued by Mr. T. C. Dennis, Superintendent of Mines. This report shows that the value of the products of the mineral industry of the province last year totalled $12,918,109. From the table of production which accompanies the statement we find that in the output of structural minerals the value of brick product was $1,272,092, cement $3,361,292, granite $482,338, marble $120,541, lime $452,330, limestone $1,570,455, sand $343,750, sandstone $5,072, slate $6,286, tile, dray and sewer pipe, pottery, etc., $326,165. Notwithstanding the general depression which prevailed during the year it is gratifying to note that the production of structural materials more than held its own, as compared with 1912.

A new pier under plan in San Francisco harbor will be supported on concrete piles 22 in. in diameter, with a mushroom base. It is planned to jet these piles into the sand to a depth of 20 ft. A reinforced concrete superstructure will be used.

Progress, Design and Construction of the New Welland Canal

Great National Engineering Work Involving the Expenditure of $50,000,000—Comparisons with Old and Existing Waterways

(Staff article)

PROGRESS in the construction of the new Welland Ship Canal, an undertaking which for magnitude and cost will rank as one of the great engineering achievements of the twentieth century, has been a gratifying feature of the work from its inception to the present time. Excavation was commenced in the fall of last year and it is expected that all the contracts will be under way early in the summer of 1914. The proposed canal is the third inland waterway to be constructed so as to form a connecting link between Lake Ontario and Lake Erie. The original Welland Canal is one of the oldest in Canada, having been commenced in the early part of the last century. As originally built it connected Port Colborne and Port Dalhousie, but the difficulties of excavation at a point known as the Deep Cut through the divide in the centre of the peninsula prohibited the use of the Welland River or Lake Erie as a source of water-supply. A summit level fed by a feeder twenty-seven miles long, extending from the Grand River which lies to the west of Port Colborne, was therefore required. Later, however, the Deep Cut was made and the water-supply taken from Lake Erie, which was and is the summit level of the canal. The lake level is somewhat higher than the Welland River across which the canal is carried in an aqueduct.

Canal Development

The possibilities of development of inland waterways traffic do not appear to have been realized at the time of the building of the original Welland Canal which was commenced in 1824 and completed some nine years afterwards. As this canal had locks of wood only 100 ft. long and 22 ft. wide, the natural expansion brought about by increasing development soon necessitated a more extensive canal scheme. So in 1841 this found expression in the enlargement of the waterway by the construction of new masonry locks with entrance locks at Port Colborne and Port Dalhousie. These locks were 200 ft. long and 45 ft. wide, with 9 feet of water on the sills. A further deepening to 10 ft. was carried out in 1860 and the bottom width of the canal was increased to about 26 ft. In 1875 a further enlargement of the canal was undertaken. The old location between Allanburg and Port Colborne, a distance of fifteen miles, was maintained, the canal prism being widened and deepened to accommodate the new size. A new location was selected between Allanburg and Port Dalhousie, a distance of 11¾ miles, for a still further enlargement to the eastward and northward of the old canal, the course of which together with that of the present canal is shown in Fig. 1. The locks on this enlarged waterway are 45 ft. wide at the level of the lower reach and 270 ft. in length between hollow quoins, with 14 ft. of water over the sills. The original Welland Canal is still in existence and is utilized chiefly as a power generator.

The original and present canals followed a route from Port Colborne across the Niagara Peninsula, running almost parallel at the northern end, entering Lake Ontario at Port Dalhousie.

Features of Proposed Waterway

The route followed by the canal now in course of construction is from Lake Erie to Welland, with the exception of a small cut-off about three miles from Lake Erie, and through Welland to the point where the present canal leaves the Welland River. The new canal takes its alignment in the bed of the Welland River, from whence to Allanburg the alignment is the same as in both the old and the present canals. From Allanburg to Lake Ontario an entirely new cutting is made on a much better alignment than the present one, which is crosses twice, Lake Ontario being reached about three miles east of the present harbor at Port Dalhousie.

From lake to lake the total length of the proposed canal is twenty-five miles, so that it is shorter than the present waterway which is 26¾ miles long. The present canal was commenced in 1872 and completed in 1887, the route at the northerly end being changed slightly to the east near St. Catharines, the canal coming out into Lake Ontario at the same point as the original one. A difference in level between the two

---

Illustrations marked * are reproduced by courtesy of Engineering News.

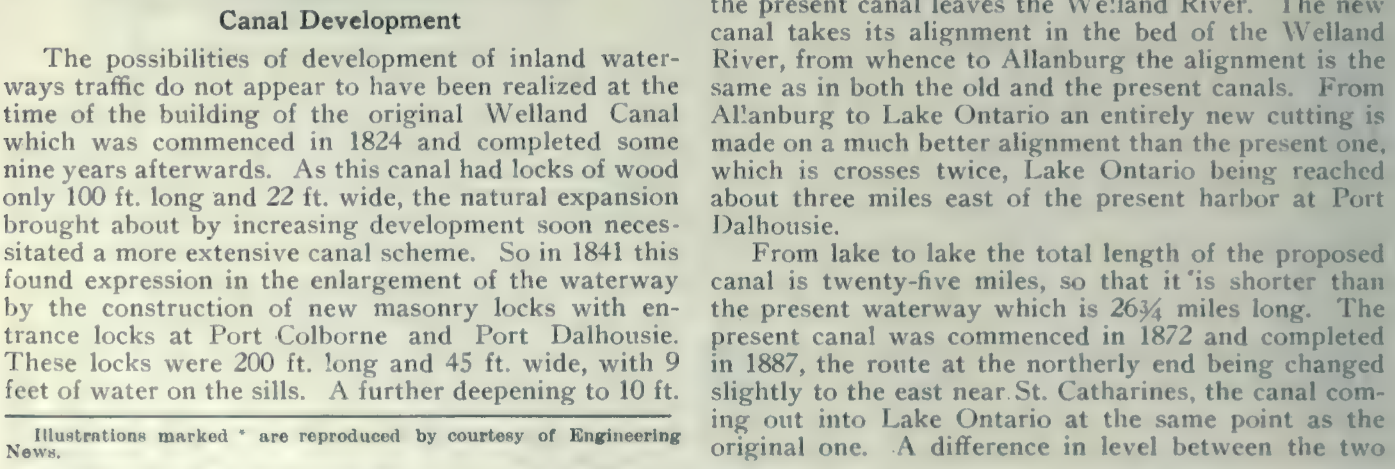
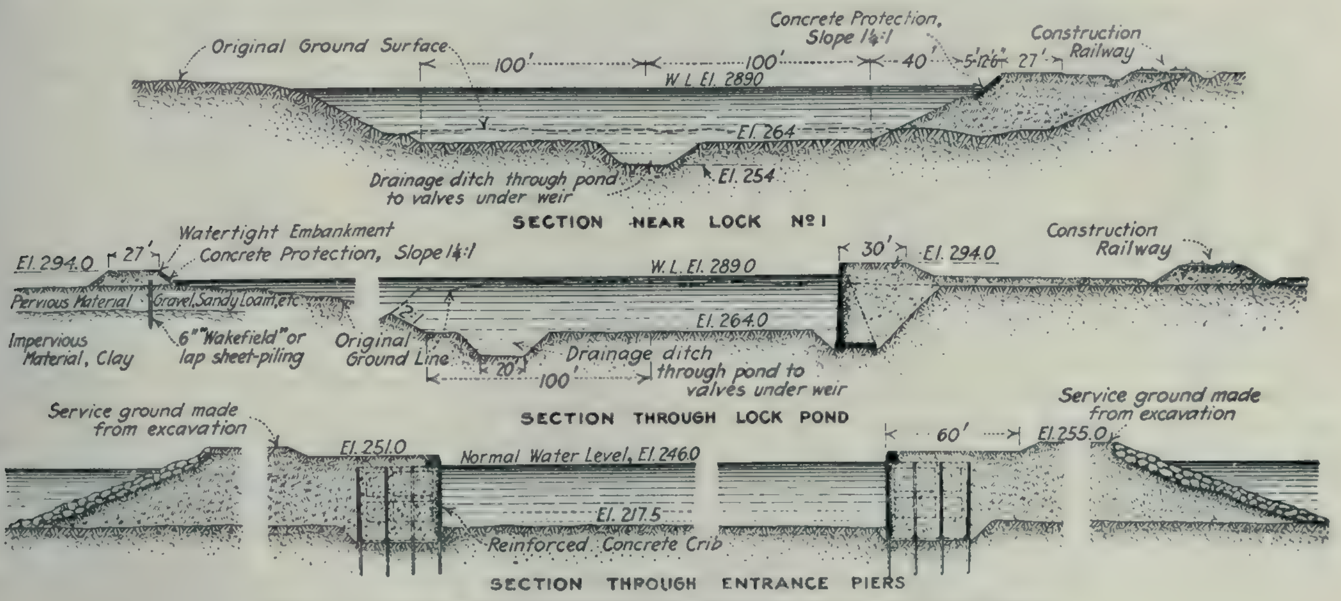


Fig. 1.—The new Welland Ship Canal, showing its course in relation to old and existing canals. The new waterway will be 25 miles long and will be equipped with seven lift locks, each 800 ft. in length and 46½ ft. lift.*

lakes of 325½ ft. at low water will be overcome in the construction of the proposed canal by seven lift-locks each having a lift of 46½ ft. The summit level from Lake Erie to a point south of Thorold fluctuates with Lake Erie with an average elevation of 573. From Thorold to Port Dalhousie it drops 327 ft. in 25 locks from the Niagara ascarpement to the level of Lake Ontario. The summit level to the elevation of extreme low water in Lake Erie will be controlled by a guard lock and weir at Humberstone, which will overcome the lift between the summit level and any higher water in the lake.

The locks will each be 800 ft. long by 80 ft. wide in the clear, with 30 ft. of water over the sills at low stages of the lakes. The original canal contained 27 locks, of which 24 were 150 ft. by 26½ ft., the remaining three being 200, 230 and 270 ft. by 45 ft. respectively. The present canal possesses 26 locks each 270 ft. by 45 ft., with a depth of 15 ft. over the sills. The width of the proposed canal at the bottom will be 200 ft., and all structures are to be sunk to a depth of 30 ft. in order that the canal may be deepened at a future date by dredging out the reaches. Drawing A in Fig. 2 shows a typical section of the canal.


Original Ground Surface
Concrete Protection, Slope 1¼:1
Construction Railway
100'
100'
40'
5'
12'6"
27'
W L El. 289.0
El. 264
El. 254
Drainage ditch through pond to valves under weir
Watertight Embankment
El. 294.0
27'
Concrete Protection, Slope 1¼:1
Pervious Material
Gravel, Sandy Loam, etc.
Impervious Material, Clay
6" "Wakefield" or lap sheet-piling
Original Ground Line
2:1
20'
100'
W. L. El. 289.0
El. 264.0
Drainage ditch through pond to valves under weir
30'
El. 294.0
Construction Railway
Service ground made from excavation
El. 251.0
Normal Water Level, El. 246.0
El. 217.5
Reinforced Concrete Crib
60'
El. 255.0
Service ground made from excavation

SECTION NEAR LOCK Nº 1

SECTION THROUGH LOCK POND

SECTION THROUGH ENTRANCE PIERS

Fig. 2.—Typical sections through Welland Ship Canal, near Lake Ontario.*

The inner harbor at Port Colborne will be deepened to a depth of 25 ft., and the old locks and regulating weir now in the centre of the village will be completely removed. The rock-cut from Port Colborne to Humberstone will be deepened and widened on the west side below Humberstone. A cut will be made across the point now forming Ramey's Bend so as materially to straighten the canal. The excavation from this cut will be rock for the greater part and will be utilized in the construction of the breakwater. A guard lock will be built in the rock-cutting a short distance below Humberstone, and when this new cut is ready for navigation a regulating weir will be built across the abandoned portion of the present canal which will be utilized as a bypass to furnish water to the canal. This lock and regulating weir will control the elevation to the summit level of the canal, which it is proposed to keep at the level of extreme low water in Lake Erie (568 ft. above sea level). The canal will be deepened and widened from Ramey's Bend to Welland by excavating a strip along the western bank. As an alternative to constructing a new waterway over the Welland River it is proposed to raise the level of the river to that of the summit level of the canal by means of a dam across the river at Port Robinson. This dam will be provided with a large overflow and regulating weir which will control the elevation of the summit level, allowing any surplus water to overflow into the old Welland River and pass out into the Niagara River at Chippewa as at present. In order to keep the river clean it is intended to allow a sufficient quantity of water to run in a continual flow.

The present aqueduct at Welland, also the bank between the canal and the river, will be dredged out. This latter waterway will be used between Welland and Port Robinson instead of the present canal, it being somewhat straighter and requiring considerably less excavating. At Port Robinson a cut will be made through the present bank between the canal and the river through which vessels will again enter the canal prism. It is anticipated that the raising of the Welland River above Welland will cause to be flooded some 1,600 acres of low land adjoining the river bed. This land however is partially submerged every spring by the flood water in the river and is used mainly for pasturage. To obviate damage to that section of land in the vicinity of Wainfleet township, which is also low lying, it will be necessary to open up most of the ditches from the point of their present entrance to the river to the intended high-water mark.

What is known as the Deep Cut (deepest cutting 66 ft.) between Port Robinson and Allanburg will be deepened and widened by cutting a slice off the western bank. Allanburg is now the junction of the present and original Welland Canals, and the water required for the latter, which is quite considerable on account of the many power developments within its area, is taken into the canal through a weir at this point.

In the canal scheme now under way it is proposed to close the present old canal entirely between Allanburg and Marlatt's Bridge near Thorold, first building a new weir at the head of lock No. 25 of the present canal to supply the above mentioned water. A dam will then be thrown across the old canal at Allanburg, and the old bed of the canal between the dam and Marlatt's Bridge will be utilized as a dumping ground for the material removed in the widening of the Deep Cut. A convenient dumping ground will thus be formed, and besides the old canal will become more self-contained, as at present the entrance works are located at an inconvenient distance from the remainder of the canal.

From lock No. 4 the future canal crosses the meadow to the north, following in part the bed of the Ten-Mile Creek until it crosses the present canal at the foot of lock No. 11, at an elevation of 382 ft. above sea level, which is the level of the present canal at that point. This will enable small vessels to utilize the Port Dalhousie entrance as at present, as far as lock No. 11. Below lock No. 3 a heavy cutting is required through the village of Homer to the bed of the Ten-Mile Creek. Below Carleton Street, lock No. 2 is located, and the pond at the head of the same lock at an elevation of 335½ ft. above sea level floods about two hundred acres of land in and adjoining the bed of the Ten-Mile Creek. Below lock No. 2 the canal follows the bed of the creek to the lake, lock No. 1 being situated just below the Lake Road, and but a short distance from the entrance to Lake Ontario.

The locks are to be constructed throughout of concrete founded on bedrock. The lock walls will be 82 ft. above the top of the gate sill, and including the necessary foundation work required below this level two of the locks will have walls 100 ft. high. A noteable feature of the lock gates is that they are of the single-leaf type. They will be constructed so as to swing on a hinge at one side of the lock, resting in a notch cut in the opposite wall. The gate at the foot of each lock will have a height of 83 ft., a length of 90 ft. and a weight of about 1,125 tons. The valves and culverts, as designed, will allow the lock to be filled in less than eight minutes, which in these days of rapid transit will be a valuable commercial asset to the new waterway, reducing as it will the time of passage very materially below that required in the present canal system. In order to give them a traffic capacity equal to the other single locks, Nos. 4, 5, and 6 locks are built in twin flights, one for up-bound and the other for down-bound traffic. A pond is provided at the head of the flight, and at the head of each of the single lift locks each pond is utilized as a regulating basin from which water to fill the lock is to be drawn. This method of drawing water from a side pond instead of directly from the canal obviates the formation of objectionable currents and surges in the canal and locks and is the method adopted for filling each of the locks. Lock No. 1, a sketch of which appears in Fig. 3, is in general typical of the other locks. The chief features to be noted in it are the regulating channel to the side of the main lock with its two weirs (regulating weir at the head and west weir) dividing the total fall; the single-leaf gates; the chain guards or fenders above and below the gates; the culvert connections between pond and lock and the concrete bridge, with draw-span, across the lock.

Lock No. 4, which is founded on shale, is built with gravity section walls, whereas locks Nos. 5 and 6 being in a good quality o fsand-stone are designed with a five-foot concrete facing to the rock to form the lock chambers. This method prohibits the use of side culverts, so bottom culverts have been used in these two lock systems.

Commencing at the south of the canal the first lift lock is lock No. 7 situated at the north end of the Erie level. A pair of twin guard gates are located here near the southerly limits of the town of Thorold as a special protection to the summit level. These gates are a short distance south of lock No. 7, the head of this lock being directly opposite the head of lock No. 24 of the present canal. A regulating basin will be formed of that portion of the present canal between locks Nos. 25 and 24 together with a pond of some 27 acres created by flooding the upper valley of Ten-Mile Creek. Below lock No. 7 is a short reach of canal with an adjacent side pond having a surface area of about 84 acres, and immediately below twin locks Nos. 6, 5, and 4 in flight are located. These three locks overcome a descent of 139½ ft. One flight will be used for down-bound vessels and the adjoining flight for up-bound, the total flight being regulated to minimize long delays in the passage of vessels through the canal.

The location of lock No. 3 is directly north of the present canal and at its head to the east side is situated the equalizing basin, a pond of 150 acres. Some difficulty was experienced in finding a location for this lock on account of insufficiency of rock for foundations, but eventually a suitable foundation was located at the present site. The pond at the head of lock No. 1 covers an area of 107 acres with a section through it, as shown at the bottom of Fig. 2. On the left is the regular slope and on the right a reinforced-concrete retaining wall fill.

Not the least notable feature from an engineering point of view is the new western breakwater consisting of a gigantic rubble mound of stone from the excavation north of Port Colborne, terminating in a timber and concrete head-block located some 2,000 ft. further out in the lake than the present breakwater. The object in building this is to ensure quiet water in Port Colborne harbor during storms.

At Port Colborne the outer harbor is at present 22 ft. deep at normal stages of the lake. The deepening of this portion of the harbor will therefore be left for a few years until the connecting channels of the Great Lakes admit of deeper navigation. The inner harbor of Port Colborne will be deepened to the proposed new depth and the old locks and regulating weir now in the centre of the village will be removed.

The outer entrance piers in Lake Ontario at the north end of the canal are placed about 1½ miles from shore where the depth of water is 30 ft. From these piers to lock No. 1 a wide channel will be dredged. The sides of this channel will be protected at the outer and shore ends by reinforced-concrete cribs (as shown in Fig. 2), with concrete superstructures along which vessels may lie. These cribs will be built on shore, launched and towed into position. The wooden false bottoms, which are held temporarily by an arrangement of struts and wedges, will be removed by a pull on the chain after the crib is sunk, and the cribs will be subsequently filled with spoil. An embankment built about 500 ft. wide will be formed on either side of the channel from material excavated from the canal between the lake and Thorold. This embankment will extend from the shore line of the lake to the outer entrance piers.

The Welland division of the Grand Trunk Railway is situated at a point where the new twin locks are to be built. It will be necessary therefore to divert the line some distance to the west. The diverted line will bear the same relation to the future canal as the present line does to the existing canal. At whatever points road or railway crossings over the canal are required, bascule lift bridges will be constructed except in two cases, where the roadway is carried on the

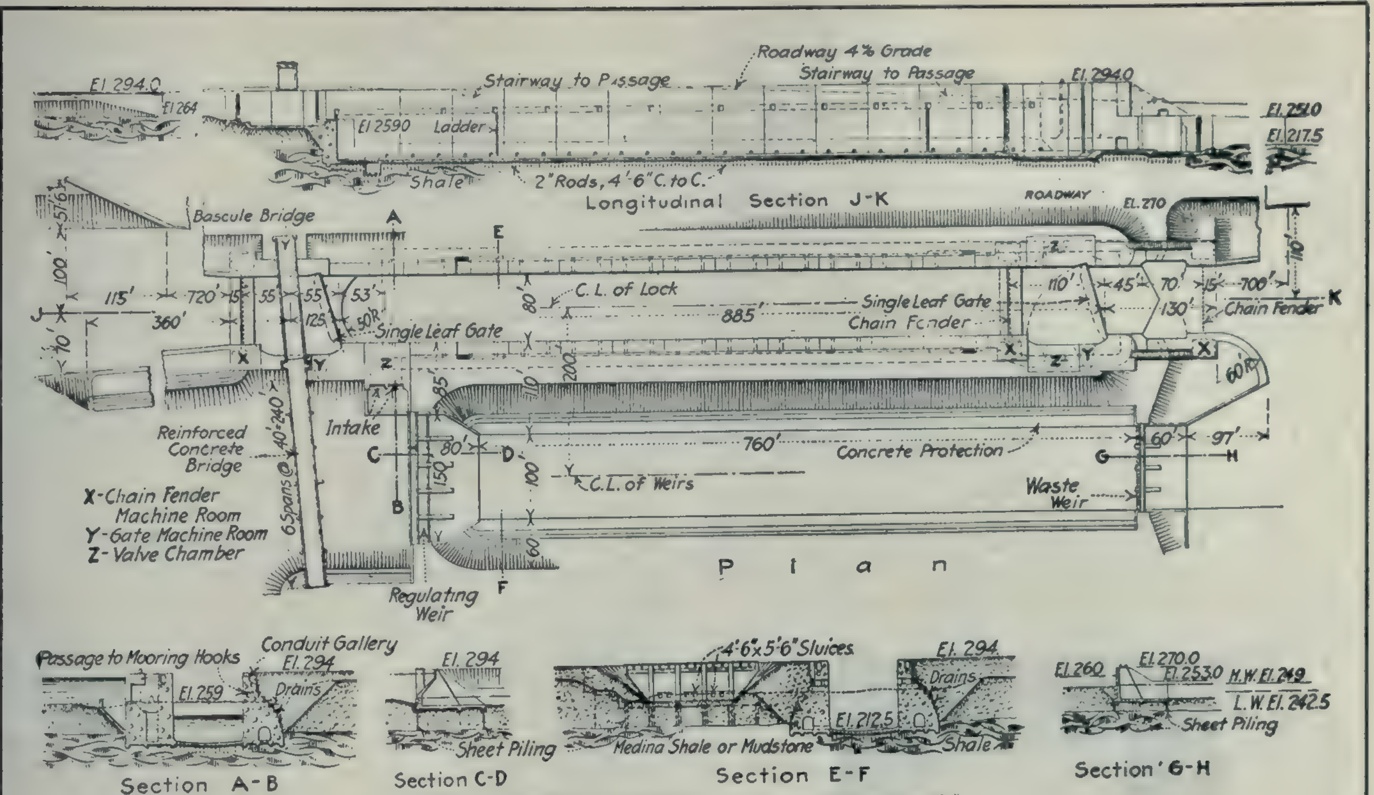


Fig. 3.—Details of lock No. 1, proposed new canal.*

single-leaf lock gates. Where possible crossings are located over the head or foot of the locks to shorten the length of the bridge.

Details of Excavations

The contract work has been divided up into nine sections, of which four have been contracted for up to the present. The remaining five will be let early in the summer. Section 1, covering the Lake Ontario entrance at Port Weller, and including lock 1, was let last summer to the Dominion Dredging Company, Limited, at $3,500,000. The contract is well under way, a considerable quantity of excavation work having already been accomplished by the firm. They have four dredges at Port Dalhousie in readiness to go on with the work in the spring. For some time past two steam shovels of the 85-ton Bucyrus type and one Class 24 Bucyrus dragline excavator with 3½ yd. dipper and 100 ft. boom, have been at work. The excavated material is being placed in the lake to form the dykes which will enclose the new harbor. The contractors have also been excavating in the canal prism and for the construction of the railway which is to be built along the west side of the canal from Port Weller to Merritton. The company are also using a No. 73 Marion-Osgood steam shovel. They have seven locomotives and about 50 air-dump cars of 12 cu. yd. capacity, as well as a number of travelling cranes and spreaders on the section, operations having proceeded with practically no interruption throughout the winter. This section consists of 1½ miles of the entrance channel and about 1½ miles of dry excavation work, including the construction of lock No. 1. The entrance channel will be dredged to the required depth. Such is the character of this section of the work that very little rock will be encountered.

Section No. 2 was awarded to Messrs. Baldry, Yerburgh & Hutchinson, St. Catharines, on October 23, the

Excavator in dumping position. Closer view of bucket and drag-line at work.

VIEWS OF BUCYRUS DRAG-LINE EXCAVATOR AT WORK ON SECTION 1.

contract price being $5,500,000. The work extends a distance of about 4 1-3 miles, commencing at the south end of section 1, and including locks Nos. 2 and 3. The work will be proctically all earth excavation to the extent of about 6,500,000 cu. yds. Sub-contractors Messrs. Yale & Reagan, of Chicago, have commenced work on the section, their plant comprising one 70-ton Bucyrus steam shovel and a Bucyrus drag-line excavator. At the upper end of section No. 2 sub-contractors the Hill-Leonard Engineering and Construction Company of Toronto, have started operations with a Marion steam shovel This firm are also putting in another Model 75 Marion shovel. On the same section another sub-contractor, Mr. Joseph Battle, of Thorold, has driven the foundation piles and fender piles for the construction of the railway swing bridge which is to be built across the present canal at a point below lock No. 11. The concrete superstructure is at present being built, and the Hamilton Bridge Company, which has the contract for the steel superstructure of the bridge, will begin operations in a few weeks. Messrs. Baldry, Yerburg & Hutchinson will shortly have a Class 24 Bucyrus drag-line and an 85C Bucyrus shovel in operation.

Mr. J. L. Weller, M. Can. Soc. C.E., engineer-in-charge, new Welland ship canal. Mr. Weller has had considerable experience of engineering work on Canadian canal systems, having been superintending engineer of the present canal prior to undertaking the new work.

Section No. 3, the contractors for which are Messrs. O'Brien & Doheny, and Quinlan & Robertson (Confederation Construction Company, Montreal), is the largest contract on the work, and is the pivot in many respects of the whole undertaking. Although confined within the smallest limits. It is just under two miles long, and passes through Thorold. The twin locks in flights 4, 5 and 6 are in this section, also the single lock in No. 7. The contract was let on October 3, the contract price aggregating about $10,220,665. Such has been the progress on the work that about 30,000 yds. of rock and about 3,000,000 yds. of earth excavation have been removed. The contractors have six steam shovels of the Marion type, which carry a 2½ yd. dipper, and have a daily working capacity of from 1,000 to 3,000 cu. yds. The Welland division of the Grand Trunk Railway, east of the town of Thorold, intercepts the course of the proposed canal, therefore it will have to be removed. For this purpose the contractors have six steam shovels of the Marion type at work excavating earth, and a small 20-ton Marion steam shovel excavating rock for its diversion. They are also installing a Model 261 Marion drag line machine, which handles a 5 cu. yd. drag line bucket with a 100 ft. boom. A double- track steel bridge, to be used as a temporary diversion of the main line of the Grand Trunk Railway east of Merritton, will be constructed, and at present a pit 80 feet in depth is in course of excavation through earth and rock to accommodate one of the piers of the structure. This diversion will be in use for three or four years until the locks are constructed. The earth in course of excavation by the steam shovels is being dumped on either side of the large dam to be built at the head of lock No. 6, the material to be afterwards re-handled, watered and rolled to make it watertight for the formation of the embankment at both sides of the entrance channel. At its highest point this dam will be about 75 ft. high and will hold back a basin containing about 84 acres of water. The contractors for this section are required to furnish contractors of sections 1 and 2 with all the rock required on their sections, as well as on section 3.

Section 5, the contract for which was let to the Canadian Dredging Company last November at about $2,000,000, extends from Allanburg to Port Robinson, is just under two miles in length. This follows the route of the existing canal, therefore the work consists mainly of deepening and widening. Mr. James Corbett, subcontractor, is getting in his steam shovel plant consisting of five Marion steam shovels to excavate in the neighborhood of 2,500,000 cu. yds. of earth.

Section 8, which cuts out Ramey's Bend, is the next section which will be placed in the contractor's hands. Section 4 is an entirely new cutting, and with sections 6, 7, 8, and 9 will be let and under way early in the summer. The time limit for the completion of section 5 is April 1, 1918; that for the other sections is April 1, 1917.

All the Bucyrus shovels and drag-lines in operation on the works were sold by Mussens Limited, of Montreal and Toronto.

As an engineering undertaking the future Welland Canal will bear favorable comparison with the Panama waterway in many respects. The great lock gate at the foot of each lock, for example, will be larger than that of the Panama, being 90 ft. long and 83 ft. high.

The Canal will cost approximately $50,000,000, and will take at least five years to complete.

The construction of the new Ship Canal is under the direction of the Department of Railways and Canals. Mr. J. L. Weller, M. Can. Soc. C. E., who has had considerable experience of Canadian Canal systems, is the engineer-in-charge of the entire work. Mr. F. E. Sterns, who is Mr. Weller's designing engineer, was for several years engaged in engineering work on the Panama Canal.

The resident engineers connected with the work at present include:—Mr. C. L. Hays (section 1); Mr. E. G. Cameron (section 2); Mr. H. M. Balfour (section 3); Mr. J. J. Aldred (section 5); Mr. E. P. Johnson (sections 8 and 9).

Of 16,600,000 h.p. available in Canada for the development of hydro-electric power, but 1,016,521 has been harnessed.

Requirements and Scope of the Consulting Engineer in Waterworks Practice

CONSTITUTING a general discussion of the life and work of the consulting engineer, an article under the above heading, written by Mr. John W. Alvord, consulting engineer, Chicago, and published in a recent issue of Engineering and Contracting, cannot fail to be received with great interest by the engineering profession in Canada. The abstract given below will doubtless be found particularly instructive by those entrusted with the management of local water supply systems. In its broader application it will appeal to all who entertain or who have ever entertained the idea of going into consulting engineering practice.

Requirements of the Consulting Engineer

In the first place, the consulting engineer must have an investigating type of mind. That is, a type of mind that can accumulate evidence, sum up facts, and procure information without coming to premature decisions. This is not the common type of mind, and usually has to be cultivated. Most of us naturally jump at conclusions, and the less we know about a subject often the more hastily we conclude on something about it.

In the second place, the consulting engineer must subordinate the desire for personal gain to the pursuit of truth for its own sake—he must be willing to face a personal financial loss if he should become inadvertently so involved that it is necessary, to do so, rather than produce inefficient results, or deliver undigested opinion. If he undertakes a problem at all, he will be expected to serve his client's interest in the light of truth and fact even if that involves a personal contest with his own client and a financial loss to himself. In other words, no man who has not a high sense of honor, a keen appreciation of principles for their own sake, and a disregard for emolument, when emolument interferes with principles, can hope to succeed, or at least succeed very long as a consulting engineer.

In the third place, a consulting engineer should have a broad experience behind him upon which to base his work. The investing public instinctively distrusts youth. The old saw, "Young men for war, old men for counsel" does not seem to lose its force as an axiom. The investigator usually demands that the man upon whose judgment he stakes his money shall have arrived at years of discretion, and in the long run this is founded on good common sense. It is a disappointment to the young man who, with his ambition and vigor, would like to leap at once into the final fruits of a long career, but there can be no better and sounder foundation laid for the work of the consulting engineer than 15 or 20 years' experience in the superintendence, construction, and design of engineering works—in subordinate position if need be—with all the experience in human nature, and the opportunities for self-improvement that that length of salaried service implies.

In the fourth place, a consulting engineer must of necessity have some capital and business experience to successfully operate in his calling. To enter the consulting field with insufficient means is not only to be daily harassed by business anxieties, but is often a fatal handicap to the engineering judgment in matters where the engineering judgment should be carefully protected against baneful influences of a financial character. There is probably no more peculiar and sensitive strain upon the morals than is afforded by the financial temptations of an insidious nature that confront the young and inexperienced engineer who has too early embarked on an independent career. The temptation to slight his work when he has named too low a fee—the temptation to accept work from a client who clearly wants to use him improperly, or the temptation to report favorably on a doubtful project because it may lead to more work—in these and a thousand other insidious ways are embarrassments created for the financially helpless, which do not so often come to the old-established and well-founded practitioner.

Ordinarily it takes a considerable amount of capital to start the practice of a consulting engineer. The less wide one's acquaintances and the less mature one's experience, the more capital it takes to provide for the cost of "Going Value," that is to say the cost of financing one's experience and personality onto a paying basis in the engineering field.

Not only does it take capital to start such a practice but it requires a considerable capital to conduct it. While it is a safe business, in that accounts are almost always good and collectible, collections are not always possible until work is done. It is safe to say that the foremost consulting water works engineers in this country require a working capital always invested in their business of not less than $10,000 to $25,000, and perhaps at times of even more.

In the fifth place, the consulting engineer must expect to do many things for the public and for the advancement of his profession without any direct remuneration; not that he should do work that can and ought properly to be paid for, but many times it is desirable for him to make original investigations costing sometimes many thousands of dollars, the results of which it is wise for him to give to the pubilc and to his professional brethren. In the matter of information the biblical injunction "freely we have received freely give" is as good an axiom in engineering as it is applied to the religious life. No successful consulting engineer ever made his mark by hoarding expensive information. Very few consulting engineers have patented their ideas extensively and remained consulting engineers. The professional world expects and demands of the consulting engineer that he be generous with his surplus time and means, and they accord honor and reputation only to those who live up to their opportunities in this regard.

In the sixth place, the consulting engineer must have the acquaintance and the long personal confidence of men of affairs who have need for his services from time to time. This is really his first and fundamental requirement but it is necessarily the result of all that has been heretofore outlined.

The work of the consulting engineer is based primarily on the personal conviction of this acquaintances after many years of observation that he can be of real use to them in difficult problems. After years of established reputation, others may come to him on the basis of his reputation alone, but in the start he must depend on this element of personal confidence. The best advertisement a consulting engineer can have is a satisfied client.

In municipal work and municipal water works work particularly, the consulting engineer labors under the handicap that rotation in municipal office often deprives him of influential friends whose confidence he has established by his work for their city in the past.

The consulting engineer is peculiarly dependent for his reputation on the fellow members of his own profession. Nobody knows so well how efficient or deficient an engineer is in any given line, as do this professional brethren. If you want to be sure to get a good doctor, inquire about the one you have in mind among other doctors in his vicinity and you will generally get a line on him. So it is with engineers, to select the right engineer for a particular problem the searcher for talent can do no better than to advise with other engineers in kindred lines. Nobody knows engineers like engineers, and an engineer who stands well with the rest of the engineering profession, and is recommended by them, may usually be safely employed.

So far we have spoken about engineers as a class. The water supplies of our several thousand cities in this country in connection with their sanitary and other municipal problems, afford, perhaps, the largest field for consulting engineering that obtains among engineering specialists. This is because water supply and sanitary problems are sporadic. In railroad work, railroad operative problems are constantly arising and are generally local to the road, consequently railroads have to continuously employ engineers expert in their work. As a result there are few independently practicing consulting railroad engineers available. In bridge and structural work, there are a larger number available but it is safe to say that at least half of the consulting engineers in this country are occupied almost solely with municipal problems, which are many and varied.

Field of Usefulness

The consulting engineer in water works practice has the opportunity to make himself useful in special ways that perhaps should be noticed in some detail.

In the first place, he is, or should be, familiar with all of the more important water supplies of the country, so as to understand in a general way their peculiar working conditions and special characteristics. In addition to a general familiarity with such plants, he should have a detailed knowledge of a large number of plants with which he has personally been identified and from which he has drawn his experience. It is quite as important that he have a good working knowledge of small plants as of large plants, for as a rule, more skill and care is required to adapt means to an end in small water plants than in large ones, besides which, one must realize that only a good perspective can be obtained when one has in mind measures which are applicable to all sizes and varieties of works.

In the second place, he should desirably have close and intimate touch with water works men and interests all over the country. He should have a specialized library of all the water works literature, carefully filed and indexed, for ready reference. He should also have the notes of his own past work so indexed and accessible that they are almost instantly available. And if he be wise he should expend a good deal of time and money in tabulating data forming a data file for ready reference on all of the more independent subjects that are likely to come before him.

A library of special water works reports by other engineers, chemists and experts, should form a most valuable part of his library, and this cannot ordinarily be accumulated without special watchfulness through the professional courtesy of his fellow practitioners, covering a considerable period of time. A well-equipped, modern, up-to-date library in a water works engineer's office represents an investment, with its accompanying files, of from $3,000 to $15,000.

In the third place, if he is to be of the greatest good to the greatest number of clients, he must have a well organized force of assistants, familiar with his methods and ideas, and capable of carrying them out, ofttimes at a distance from the home office. Engineering assistants of the proper type of mind needed by the consulting engineer must be trained in his own office by a well arranged system of precedence, promotion, and personal interest and instruction. With such a force the personal influence of the chief of the office can be spread out over a very large field without making the cost in any one investigation unduly expensive, because in a well organized office no man should have to do what a less expensive man can do equally well, and the chief of the office can confine and limit his time to those things only which are required for direction and general supervision to the financial advantage of his client.

In the fourth place, the water works engineer must continue to be a close student of the art all of his professional life. So soon as he begins to relax his attention in this direction, so soon does he begin to drop back and be in danger of being superseded. No matter how busy he may be, or with what great responsibilities he may be charged, he cannot afford for one instant to relax his study time. New methods must be investigated where they have promise. Water works literature should all pass under his eye, at least to the entent that he catches the meaning and purport of every important water works article, paper, or book that is presented during the current year. The water works conventions in which he is interested must be attended, and he must see to it that he is constantly rubbing up against men and minds and keeping up with the current of thought in his special line of work. The exacting requirements of this kind of study, in connection with the business of operating an office, pursuing special problems, and at times shouldering the responsibilities of construction, is a severe requirement, and with most men compels much evening work, especially in early life. The social sacrifices which most of the prominent water works engineers of this country have undergone would surprise many a young man who saw only the emoluments and the rewards involved .

In the fifth place, the water works engineer in consulting practice should have breadth of view outside and beyond the strict limit of his own profession. His more especial field is, however, a broad one and may be outlined as follows:

In water source inquiries he must be informed in meterology, hydrography, and storage problems as well as all of the specialized work done in the underground waters. In questions of quality, he must have a general working knowledge of chemistry and bacteriology so as to make correct interpretations, weigh relative advantages and disadvantages of different waters, test those in use, guard the community against disease and epidemic and decide on questions of filtration. In mechanics, he must be well acquainted with all of the various machines, appliances, and fuels, and deal with questions of combustion, station economy and transmission problems, all of which go to the successful solution of hydraulic power equipment and economics. In hydraulics, he must, of course, have a wide knowledge of the various properties of water and its control. In law, he must be proficient with the details of municipal methods and checks, and the relations expressed in contracts. As an administrator, he must know how tactfully to manage men, talk to Boards, Councils, Committees, deal with contractors, and superintendents. In economics, he must know how to reason about finance, understand the conservation of capital, relation of time to cost, and the specific economic questions that always accompany matters of public policy. In matters of public health, he must be fully acquainted with the theories of disease, the etiology of epidemics, and the laws and methods of controlling the sanitary surroundings of the modern community. Now all of this means that to the owners of the water supplies of this country there is available on comparatively short notice in a considerable number all of the means and requirements of an organized force, for the rapid study and solution of the many difficult problems that occur in the art of municipal water supply.

Probably the greatest advantage that occurs to the local water supply management from the engagement of the consulting engineer, lies in the fact that to the solution of local problems can be brought a very wide range of comparative study with the possibility of improved methods and the application of a variety of means. This comes only through a wide acquaintance with the successful ways in which difficulties are overcome elsewhere. The more water works officials and managers mingle in the water works conventions or visit varied plants in the different parts of the country, the more they realize the value of this broader aspect of their problems, and appreciate the work that the consulting engineer can do for them.

A second valuable office which the consulting water works engineer can perform for the local water works is to bring to its investigation a mind fresh, unbiased, and free from any previous local tradition or precedent; not that local knowledge is not important and valuable and must always be carefully considered, but ofttimes a review of many possible methods are necessary, and such a review often throws certain methods into strong relief that might otherwise be passed by. No one knows better than the consulting engineer himself that logical research among facts, with a correct and unbiased summation, may often reverse a pre-conceived opinion held at the beginning of the investigation.

A third valuable aid which the consulting engineer can give to the local water works management is to give perspective to the problem in hand by shaping up all the alternatives, so that after a series of projects are complete on comparative basis the management can see as clearly as the consulting engineer why a certain course of improvement is desirable and necessary. Indeed, it should be the special aim in all engineering reports to so arrange the data and contrast the opposing courses of action in a series of estimated projects that the desired decision shapes itself almost unconsciously from the facts contained in the report. It is often well in comparative work of this kind to include projects that are not favored for the sake of fairness and to throw into stronger relief a desirable selection.

The consulting engineer therefore, is not a dictator or an autocrat. He is not a wizard or a prophet. He is simply an intelligent human being who has learned how to lay hold of a special problem in a patient and orderly way with the means that are open to any one, and finally dissolve the mists that hang about the difficulty so that the layman can understand the matter as fully as the engineer. All this is accomplished by taking one step at a time, with a reason for every step.

Only the more intelligent of the water works community utilize such services. In a large majority of water works plants the consulting engineer is unknown, or, if known, he is called only rarely to remedy blunders, or a succession of blunders, caused by overconfidence. Particularly is this true in municipal work. The rapid rotation in office of the American municipal official causes him to imagine that he must decide all matters off-hand as best he can, and the idea that many municipal problems are matters for careful and specialized study does not ordinarily appeal to him.

Only as we advance in civilization and better government will we realize that a thought must precede an act, and the more important the act the more necessary it is to have careful preliminary thought.

Strictly speaking, the consulting engineer is one who gives his time wholly to advanced and specialized study. As a practical matter, however, most consulting engineers undertake more or less construction. This is, in the main, desirable as it keeps them in touch with the practical side of their profession and prevents their becoming mere theorists.

Some consulting engineers in water works work limit themselves annually to a few large undertakings in construction, while others will undertake a limited amount of all kinds of construction, both large and small. The latter, of course develop a larger working organization than the former, and while a greater variety of practical experience results, probably such engineers have less time for the studious side of their profession. Nearly every consulting water works engineer has some specialty to which he has given more than ordinary thought and attention.

Consulting Engineers' Fees and What They Call For

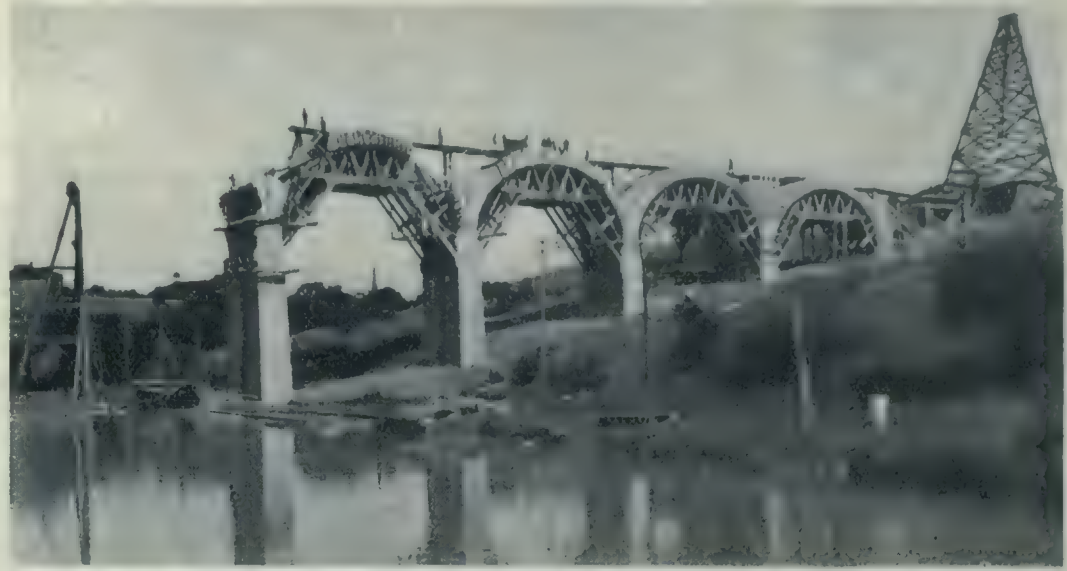
The fees which water works engineers receive cause them to be regarded ordinarily with some envy by their salaried brethren, but there is also another side of the picture. The better class of well-known consulting engineers ask $100 per day for their time, $50 per day is common, and from $200 to $250 is not unusual, but such men do not expect to do any work that can be just as well done by a competent assistant, so that the amount of time which they ordinarily charge to a problem is quite limited. Nor can they expect to maintain that rate constantly no matter how busy they may be. The business of their office, their correspondence, time taken for special studies, attendance at conventions, and committee work, make large inroads on their annual schedule, and it is safe to say that the waterworks consulting engineers are one of the most approachable classes of men. They do not expect to earn money all the time. The expenses of a consulting engineer are usually quite large. He must be a member of many technical societies and attend their conventions. Often he is called upon to do elaborate and extensive committee work in this connection. In many ways he finds it desirable to make much independent research. It is safe to say that a consulting water works engineer who has offered him all the work he can attend to, will be unable to properly charge up more than two-thirds of the calendar working days in the year and will often otherwise expend from one-sixth to one-third more of his time for the benefit of his clients, his profession, and his office efficiency.

The work of the consulting engineer calls for a great deal of arduous travel—from 20,000 to 60,000 miles a year for the busy man. It takes a robust constitution to stand all the changes in climate, winter and summer, with all the varied diet and hotel life that continual travel involves. The engineer is usually expected to work from 10 to 16 hours a day when away. Often many nights a week must be spent on a sleeping car, and with anywhere from 100 to 200 days a year away from home, life is not always a joy.

But the work of the consulting engineer unquestionably has its own peculiar rewards, for he is thrown into contact constantly with bright minds. He is constantly confronted with new and interesting problems, and filled with the zest of being needed and useful. Charged with great responsibilities for the public health and welfare, his work is undoubtedly most stimulating and inspiring.

The National Builders' Supply & Enamel Concrete Brick Company, Limited, Montreal, of which Mr. H. C. Harding is managing director, will start their brick plant at Mascouche, P.Q., some time this month. A special train from Montreal will convey a party of Montreal and Toronto architects as well as prominent engineers and contractors from these and other Canadian cities, and the plant will then be officially started.

Mr. E. R. Doe, of Victoria, B.C., who died recently at the early age of 47, was head of the well-known contracting firm of E. R. Doe Bros. With his brother he completed successfully several important engineering contracts for the Canadian Pacific Railway, among which may be mentioned the docks extension some seven years ago, and a large portion of the work on the new terminals on the Songhees Reserve.



Reinforced concrete arch bridge under construction at St. Catharines, Ont. This bridge, which connects the city with a new residential suburb, has 13 spans, 56 ft. centres and a total length (exclusive of approaches) of 700 ft. The width is 30 ft. and the height from water level to roadway 71 ft.

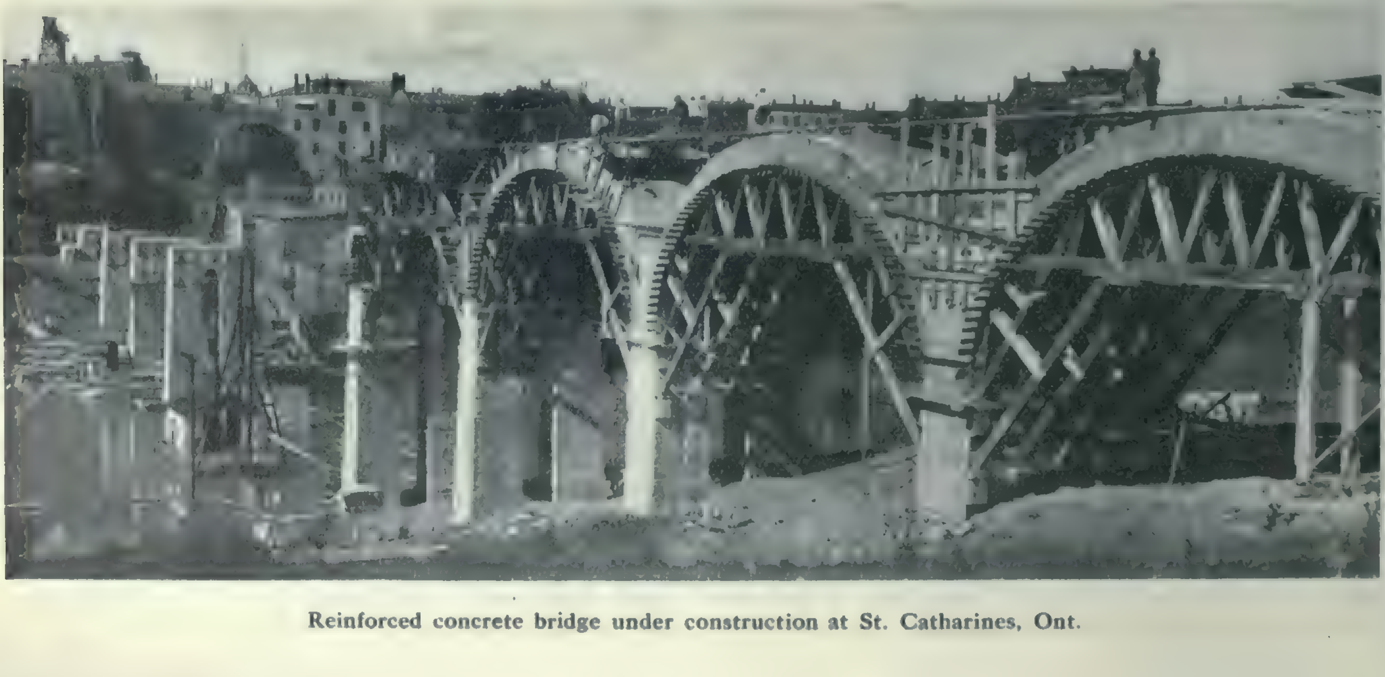
Reinforced Concrete Bridge at St. Catharines, Ont.

BRIDGE construction at St. Catharines, Ont., promises to be an important factor in the extension and development of that city in the next few years. St. Catharines is built more or less in a half-circle, following the valley of the old Welland Canal. Its location is to the north-east and west of the disused waterway, leaving the southern section practically undeveloped. It is to open up this section of the city that a new concrete bridge is being constructed. The main proportions of the new structure are: extreme length, 700 ft.; width, 30 ft.; height, 75 ft. The bridge is constructed of solid concrete throughout, and when completed will have thirteen elliptical arches, each arch having a clear span of 50

The bridge is designed to accommodate both vehicular and pedestrian traffic, and will have a 25-ft. roadway and a 5-ft. sidewalk.

Mr. W. D. Scott, of the city engineer's department, St. Catharines, has charge of the work, which was commenced in October, 1912, by day labor. As will be seen by the photographs here reproduced the bridge is about half completed. The remainder of the work will be done by contract, which is to be let in a few weeks.

In the making of the foundations and the construction of the bridge up to the present, about six thousand barrels of Canadian cement have been put in. The cement was supplied by the Canada Cement Company.



Reinforced concrete bridge under construction at St. Catharines, Ont.

Engineering Topics in the Old Land

Status of Incompetent Engineers Maintained by the Work of the Specialist—Special Training Required for Road Engineers

By our London Correspondent

SPECIALIZATION is year by year rendering the way of the incompetent easier. When buildings were composed of brick, stone, timber, slate and cement, an architect was at least competent to prepare his own plans. The introduction of metal—a material foreign to him—was the first step in the architect's downfall. Even a cast-iron girder, stanchion or storey post was beyond his ken. He was (or prided himself that he was) an artist rather than a constructor, and he did not bestow that care upon his sections that he did upon his elevations. Steel frame construction cast him down pretty considerably, and when reinforced concrete came to the front he sank finally into an abyss of despair, and delegated his work to the engineer. But the engineer, placed in the scales, was found wanting. His knowledge was too diffuse, too general; and it was not until the exigencies of modern building evolved the constructional engineer that really satisfactory work was assured. Manufacturers were quick to realize the possibilities of the constructional engineer as an addition to their staff, and scarcely a firm of repute exists now that has not its department for the assistance of the outside incompetent. In reinforced concrete this is especially the case, and the public would have a shock could it know to what an extent manufacturers and contractors, who afterwards carry out a work, are responsible for its design. It is doubtless better, so far as the safety of the public is concerned, that these expert firms should undertake the responsible work of design than that it should be left to the mere architect; but the system has many grave disadvantages. Among an architect's duties is the superintendence of works as they progress. He is expected to be master of every detail and to be able to detect the least flaw or blemish. How then does he act when the works are foreign to him, when the plans and specifications have been prepared by a specialist firm, and when that very specialist firm is executing the contract? The scandal has become so grave in England that the Local Government Board have had to raise serious objections to many reinforced concrete designs brought forward by municipal engineers, simply because the board saw that the engineers had but an imperfect knowledge of their subject and were relying solely upon the advice given gratis by manufacturers whose fingers were already very deeply imbedded in the pie. It may be argued that municipal engineers are not expected to be, and are not, either architects or constructional engineers; but a fairer way to put it would be to say that unhappily the board have no control over either architects seeking free designs or constructional engineers supplying them. The system hits the specialist engineer very hard, but it is a perfect gold-mine for the incompetent. One of the first duties of the central committee when it is formed (as it is to be hoped it will be some day) should be to obtain legislation prohibiting a man from affixing his name to plans not of his own preparation. Brain (in the engineering profession at least) might then come into its own!

The necessity for special training of road engineers is a subject which is claiming a large amount of attention here. To use one of the most hackneyed phrases of the day "self-propelled traffic has come to stay," and to use yet another, "the advent of the mechanically-propelled vehicle has revolutionized road-making methods." There was a time when highway construction (including necessarily highway bridge construction) formed no unimportant part of the work of the civil engineer. Work of this nature is now almost wholly carried out by the engineers to municipalities or county authorities, and it comes as a shock to find one of the latter advertising for an engineer possessing a qualification whose acquisition demands no experience in road construction and maintenance. "Applicants," ran the advertisement, "must be members or associate members of the Institution of Civil Engineers," and while such qualification may (but not necessarily must) be obtained by examination, the examination may be passed without knowledge of the subject referred to. There is no doubt that the county authority acted in good faith, erring through sheer ignorance; and it is of the highest importance, in the interest of good road administration, that the certificate of the premier institution should be appraised at its true worth. With two institutions holding examinations in municipal engineering (in which road construction and allied matters hold prominence) it is in the last sense ridiculous to compel municipal engineers to hold a qualification which affords no proof of their fitness to undertake the duties entrusted to them. The question is far removed from an insular one, for in more countries than one the "representative" civil engineering body represents every grade of engineer except the municipal. That a municipal engineer should be a civil engineer goes without saying, but civil engineering must form only part of his training, and the whole is greater than the part.

The manufacture of cement in the electric furnace, hitherto made difficult by the formation of calcium carbide that ruins the cement, has been made practicable by the newly-patented process of a Swedish engineer. The method of overcoming the difficulty consists in adding a metallic oxide to reduce the carbide. Iron oxide has proven a suitable material, and, instead of including this in the charge of the furnace, it has been found sufficient to add the powdered oxide to the cement product taken from the furnace.

An employment bureau has been established by the Boston Society of Civil Engineers for the benefit of its membership. The bureau is intended to be a medium for securing positions for its members and applicants for membership and also for furnishing employees to members and others desiring men capable of filling responsible positions. Two lists are kept on file at the society rooms, one for positions available and the other of men available, giving in each case detailed information.

A Practical Discussion of Estimating Methods in Building Work

By Henry A. Hoyt

CONTRACTORS are by necessity estimators. Either they estimate the cost of building construction themselves, or, in the case of larger concerns employ estimators, or "quantity surveyors," as they are known across the water. In either case, the final success of a building contract depends vitally on two results—first, getting a price for it, and second, erecting the said building for the said price, plus the desired margin.

Recently a card has been circulated in building circles bearing a sort of advertisement, and on one side the following: "Contracting, Like Horse Racing, is Due to Different Opinions." Usually the "different opinion" is the direct result of great differences in the method and manner of estimating the cost of construction. It is probably a fact that no two contractors prepare estimates and recapitulations of materials and labor in the same manner. This is not necessary always, but some system or near-system should be employed. Most of us have seen the picture entitled "The Successful Contractor," showing a builder at his desk, deep in thought, hand in his hair, and supposed to be saying, or at least thinking, "What did I forget?" This, unfortunately, is too often true. The writer has seen successful estimates prepared on slips and scraps of paper and used envelopes and the like, but the element of success and certainty involved would have been more secure, and at least more satisfactory had more system been used. It is of secondary importance, the kind of system adopted; in fact, it is just as bad to over-systemize the business of estimating till the system eventually swallows up the business in the deadly overhead expenses. One very well-known general contractor uses large blank books, weighing many pounds, and everything is kept in this book, even to the minor figures used to get off the quantities. It finally resembles a school boy's scratch pad. Another well-known contracting engineer, a man of a vast amount of experience, keeps everything pertaining to one estimate in a heavy, large manila envelope, and these are filed away eventually by name and number. A certain well-known contractor uses a large loose-leaf book, and invariably carries it around the country with him wherever he goes. He became known to several of us as the "black book man." Another contractor once made up his figures in a certain school competition in the lobby of the local hotel, wrote out his bid and walked away, leaving his estimate sheet on the hotel desk. One of his competitors walked off with it and then cut his own estimate. Very foolish and careless of both of them, but it so happened that neither of them got the contract. One contractor on a large public building competition had his bid neatly typewritten on his stationery with a space for the final amount left blank. This he filled in at the desk of a local bank and carefully blotted the amount with a new blotter. Soon another contractor sought out the same place to fill out his bid and learned the amount of the first man's bid from the blotter, mirror, etc. Sounds "fishy," but it's true. All of the foregoing are incidental reminiscent experiences only and show the great diversity of methods employed by builders. Probably more errors creep into estimates, especially errors of omission, by the use of printed estimate forms. No two buildings are sufficiently alike to permit of this form or blank being a success. Many of the printed items will be used on one building and not on the next, and if you place no figures after an item not involved in the structure in question, you are very liable to omit some figures from some other item of vital importance to your recapitulation. This opinion on the "printed blank" question will be disputed by some good estimators.

Recapitulation of Estimate

When you get a set of plans to bid and estimate from, first make one person responsible for the recapitulation of the estimate. Let that person read the entire specifications through, examining the plans meanwhile carefully and explicitly. Then make up a full and complete tabulation, synopsis or recapitulation, and have it so correct that you can depend on it as final, knowing that when all items are filled in and carried out the estimate will be complete. The correct way to take off the estimate is "as the building would be built." Always remember "order is heaven's first law," and make out your estimate in its regular order. Some make up the estimate alphabetically, but "elevators" and "excavations" are rather far apart in the usual order of building erection. Decide early what portions of the work sub-bids will be asked upon, and even if sub-bids are taken, "take off" the same yourself if you have time and are sufficiently capable. Get several bids on each item asked for if possible. It is hereby respectfully admitted that the ideal method is no sub-bids on anything till after you get the contract signed for the job, but as long as present methods of contracting exist on this coast sub-bids will continue to be invited and used by general contractors as a class. Make mental or written notes of errors or omissions in drawings or specifications, and if serious, take it up at once tactfully with the architect, but do not take up minor discrepancies with him that would make no difference with your estimate. Your time should be worth as much as his, possibly more.

Checking up all quantities and minor figures in an estimate should not be necessary if the work has been well and conscientiously performed. There are many differences of opinion on this item of re-checking one's estimate, but if many jobs are figured it is enough work to estimate once. (One estimates for nothing enough usually.) If the estimate is expected to be re-checked one gets into the serious habit of depending too much upon the said re-checking. The crucial test of a contractor's fitness for his work is his ability to handle men and operations successfully, but second only in importance is his ability to estimate the probable cost of construction. These two qualifications are not usually found in one man, but if so found he should make a successful contractor. Often successful contracting firms consist of two persons—one whose special aptitude is organizing and handling men, and another whose natural bent and training fit him to estimate costs, keep records, compile statistics and cost systems, and to act with his partner in an advisory capacity on business and buying matters. This ideal combination originates usually from a good foreman and a young civil engineer.

Evidently the building business had its drawbacks and failures early in the history of the world, else the following would not have been a seemingly necessary precept of Holy Writ: "For which of you, intending to build a tower, sitteth not down first and counteth the cost, whether he have sufficient to finish it? Lest, haply, after he has laid the foundation, and is not able to finish it, all that behold it begin to mock him, saying, 'this man began to build and was not able to finish.'" This would probably be the experience of many an owner were it not for the bravery and courage of the average contractor, who "sitteth down first and counteth the cost," and then "puts up a bond and takes all the chances."

It is convincing that many low bids, and high ones too, for that matter, are, as Dr. Johnson says, "the result of sheer ignorance" as much as a desire in the face of common experience to prove that two and two equal five. Very seldom are serious mistakes made when one follows his own good judgment. There is no such thing as time in proportion to cost in estimating. On some buildings an estimator might spend three or four days on millwork alone, while on another a few hours would suffice. A thousand dollars of hardware might occupy as much time to take off as ten or twenty times that amount in brick or concrete work. Always keep the sub-totals of your estimate separate and complete in themselves. You can then always with safety alter or change price or quantity without making a risky change clear through the estimate.

Some contractors add the profit desired to each item or sub-heading; this is wrong practice; get the exact cost and add "all the profit at once." Never under any circumstances base your final proposal on an estimated cost given by the architect or engineer in charge of the job. Many times this pre-estimate is correct in quantity, but not in price; often the reverse is true. Depend upon yourself and not the other fellow. Also be your own price maker, even if your estimate is made up by an employee. The diversity of figures of sub-contractors requires your best judgment always. It is not always wise to use the lowest sub-figures you are offered, even if the low man is presumed to be entirely responsible. It usually leads to trouble and dissatisfaction later. Avoid verbal sub-bids, and be sure that bids tendered read "according to plans and specifications." Do not use figures based on quantity lists other than your own when your contract is over the plans and specifications.

Use Text Books Conservatively

Be very careful of making up estimates from some of the estimate books published. There are a large number of them that are of valuable assistance, but entirely inadequate for the constantly changing conditions and prices of the building industry. Be your own estimate book as far as you can and keep a clear record of costs. All of the foregoing suggestions and experiences are somewhat rambling and desultory, but may prove of more than passing interest to other contractors.

Several years ago there appeared in this magazine a summing up of the general qualifications of a contractor, taken from a speech of a prominent New York City contractor, and the wording was so true, so real, and so worthy, that it will readily bear repetition here: "There is no class of work that takes as varying qualities or so many qualities as contracting. It appeals to men who are optimistic and to those who have born in them the longing for doing things. The contractor must be a man, first, of that most uncommon thing, common sense; and he must have physical sense, the sense that tells a man without calculating where lies the centre of gravity; the sense that tells a man values without estimating, the sense that tells a man quantities without measuring. He must have magnetism in order to gather his men about him. He must have reputation for justice in order to hold them. He must be forceful in order to inspire energy in others. He must be a lawyer and a buyer. He must have the ingenuity of the inventor, and the grasp of the field marshal. He must be a diplomat and he must be a politician. He must also know when not to be a politician. He must be a financier, and I regret to say, in these days, an advertiser, and he must be a prophet." And the writer most respectfully adds to the opinion of this eminent contractor the words, "and then some."

Hydraulic Dredge for Arrow Lakes, B. C.

On account of the pressing and increasing demand for dredging in the interior lakes of British Columbia, the Dominion Public Work Department have decided to provide a modern dredge for use in that district, tenders for which have just been taken.

The dredge, with the exception of the upper housework, is to be constructed of steel throughout. It is to be of the "cutter suction" or "hydraulic" type and will be self-propelling. The hull will be 116 ft. long over transoms, 30 ft. beam, 8 ft. 6 in. deep and will draw about 3 ft. 6 in. of water in working trim. The dredging capacity in free material will be about 250 cubic yards an hour. Plating at bow and stern will be made heavy enough to enable the dredge to steam through comparatively heavy ice without injury to the hull. Dredging depth will be 30 feet, with ladder inclined at 45 degrees.

The rotary cutter for breaking up the material to be excavated and feeding same to the suction pipe is worked by a powerful double cylinder engine bedded on the ladder and will be suitable for dealing with sand, clay, and gravel up to about six inches in size.

The ladder, which is hinged at its inboard end to the deck of the dredge, will be raised or lowered by wire rope tackle from a steel boom supported at the outer end by wire guys from a steel "A" frame. The suction pipe from the cutter head will be carried inside the plating of the ladder, being removable for examination or repairs, and connected to the stationary suction pipe on the dredge by means of a flexible rubber gooseneck.

The dredging pump will be of the usual type but fitted with a special design of stuffing box and an oil-lubricated thrust bearing in which the pump shaft collars revolve between shoes lubricated and cooled by oil continuously pumped in under pressure. With this method of cooling, the collars and shoes will be subject to very little wear, which is always excessive when water with its inevitable proportion of gritty matter is used. The pump will be driven by a triple expansion marine type steam engine, direct connected to the impeller shaft.

The boiler will be of the water tube type, especially designed for burning crude oil as fuel but will be so arranged that it can be quickly fitted up to burn coal. Fuel oil will be carried in two thwart-ships tanks of about 200 barrels total capacity, built in the hull. Coal bunkers of about 40 tons capacity will also be provided.

The propelling engines will be of the regular sternwheel river steamboat type with cylinders 14-in. diameter by 60-in. stroke, driving a stern wheel 18 ft. diameter. It is expected that the speed of the vessel when steaming in smooth water will be about eight knots an hour.

There will be two spuds, one forward and one aft. The former can move in a vertical direction only and remains raised when the dredge is working. The latter can oscillate in a fore and aft direction, and is fitted with a steam thrust cylinder by means of which the dredge can be moved ahead when changing cuts.

Swinging or manoeuvreing the vessel when dredging is accomplished by means of wire rope cables attached to ground anchors and leading to pulley blocks secured to the ladder near cutter head, thence through fairleaders on deck to a pair of drums driven by a two-cylinder engine located on deck just forward of the dredging pump space. This engine also has drums for handling the ladder tackle and for raising the forward spud and will be handled entirely from an operator's room on second deck forward.

All auxiliary machinery is to be of the highest class and will include the following:—Independent surface condenser with combined air and circulating pumps, "Weir" type float regulated main feed pump, "Weir" type service donkey pump, duplex sanitary pump, outside packed duplex pump for supplying water to stuffing box of dredging pump, duplex pump for circulating oil to thrust of dredging pump, hand power test pump, etc. Steering the dredge when steaming from one place to another will be effected by means of a direct acting automatic steam steering gear manufactured by the Heaps Engineering Company, of New Westminster, B.C.

Owing to the fact that the dredge will frequently operate at a considerable distance from a repair shop, a very complete outfit of machine tools will be provided. These will be located on deck on each side of the dredging pump hatch and will each be direct driven by an electric motor. Current for these machines will be generated by a 15 kw. dynamo direct connected to a steam turbine. Storage batteries of large capacity will also be provided so that the electric lighting service can be kept in operation for a considerable time after the generator is shut down. The lighting system is most complete and will include a powerful electric searchlight located on top of the pilot house.

A three-ton capacity overhead travelling crane will extend completely across the dredging pump space, and provide means for lifting pump or engine parts and delivering them close to doorways in the sides of the lower house, as well as serving the machine tools.

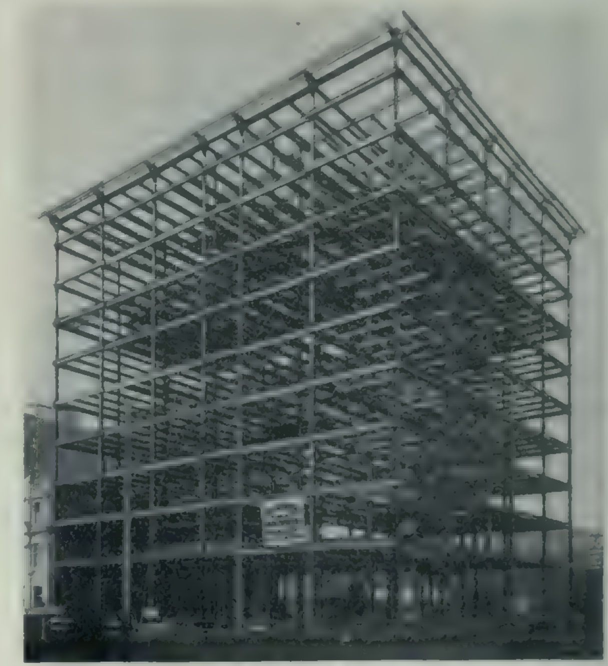
On the second deck ample living and sleeping accommodation will be provided for a complete single crew. On the third deck there will be two staterooms with bathroom between for the use of engineering officials when making their regular visits of inspection. Cabin furnishings and galley equipment will be of the most complete description.

Forty pontoons for carrying the discharge pipe are to be provided. They will be constructed entirely of steel and be fitted with adjustable pipe bearers and saddles of special design. The discharge line will be of lap welded steel pipe in lengths convenient for handling and will be connected together with rubber sleeves clamped on.

The dredge and its auxiliary equipment were designed by Mr. H. A. Bayfield, Mem. Am. Soc. Mech. Engineers, for Messrs. Cartwright, Matheson & Company, civil engineers, of Vancouver, with whom the Public Works Department has placed the order for the designs. The drawings, of which there are about thirty sheets, include all details of the hull and machinery and were prepared in the remarkably short time of three months.

Structural Features of the McLeod Building, Edmonton

THE erection of the structural steel frame of the new office building for Mr. Kenneth A. McLeod, at Edmonton, has been completed and the general contractors are about to proceed with the completion of the structure, a photograph of which is here shown. The building will have an entrance frontage on MacDougall Avenue of 118 feet, will be 100 feet deep, and ten storeys high. The exterior is to be of ornamental terra cotta and face brick for the street elevations, and will have ornamental-iron entrance and store fronts. The Dominion Bridge Company, Limited, of Winnipeg, supplied for the building over 950 tons of structural steel, the entire of which was erected in 29 working days. The foundations are steel I-beam grillages, made up of 18 and 20-inch beams from 10 to 12 feet long. The columns are all rolled H-sections, three storeys in length.


Steel frame of the McLeod Building, Edmonton.

The ground floor is 19 ft. 5 in. high and will contain one large store, three small stores and two shops flanking the entrance. The vestibule and entrance hall will be highly decorated with marble and ornamental-iron work. There will be eight office floors, each with twenty office rooms with public toilet and vaults. A light court 39 ft. wide by 64 feet long will give exterior light to every room. The attic floor will contain house tanks and machinery. In the basement will be the engine and boiler room, with machinery space and storage. The steam heating system will consist of two horizontal tubular boilers with Cochrane-feed water heater, two boiler-feed pumps, and a vacuum pump, also a hot water heater with house pump in addition. Two steam or motor generator sets of 75 kw. capacity will be installed for light and power. The entire building will be gas-piped and will be cleaned by a vacuum cleaning system. There will be three passenger elevators, having a travel of 112 feet, with cages 5 ft. by 6 ft., and ornamental iron grille enclosures.

The floors throughout will be terrazzo, and all interior trim is to be quartered southern white oak. Hollow metal will be used in the windows. The architect is Mr. John K. Dow, of Seattle. The general contractors are Messrs. Olson & Johnson of Missoula, Montana and Edmonton, for whom the work is being superintended by Mr. Frank L. Magee.

Quicklime Thaws Frozen Ground

In describing some difficult sewer construction at West Liberty, Ia., Charles P. Chase, the engineer in charge, gives the following details regarding the use of lime to overcome frost:

"The work which was described in a recent issue of Engineering News, was carried on through the whole winter when the ground was frozen to a depth of 4 ft., in which state it resisted all efforts of a trenching machine to break through it. The lime was spread over the frozen ground, covering the width of the trench to be opened and was then broken up into small pieces and covered thickly with straw, hay or manure. Water was then poured on the straw so as thoroughly to slake the lime. Hot water was found best and hastened the slaking. The covering retained the heat, which, with the hot water, penetrated the frozen ground sufficiently to enable the trenching machine to make headway."

A New York contemporary, "Architecture and Building," in an effort to establish a connection between architecture and the stage after seeing a performance of "Omar the Tent-Maker" has something to say about the "architectural activities" of Omar and expresses the opinion that he had the makings of an excellent architect. This is rather a far-fetched allusion. We can offer our contemporary something far nearer the mark. Mr. Martin Harvey, whose recent performance of "The Only Way" and other plays in Canadian cities has brought him into such prominence, is the son of a well-known naval architect and was intended for his father's profession, but developed an early predilection for the stage. Mr. Harvey really has the makings of an architect. He is excellent in the portrayal of things that are not, he makes a hobby of drawing pictures, he gets his money easily, and, again, he is an excellent actor. Are there any further desiderata?

Mixing and Placing Materials for Concrete Roads

IN the construction of concrete roads, probably no really important part of the work is given less consideration, in specifications and in the field, than the actual mixing and placing of the concrete

The following notes, based upon observations in the field, and the results of tests, were prepared with a view of pointing out the difference between good and bad practice, and to serve as a basis for recommendations covering this phase of the work.

Mixer.—The concrete mixer should be of the batch type provided with an automatic water tank, traction drive and power loader. Mixers having a boom and bottom dump bucket of sufficient size to convey one complete batch for placing the mixed concrete, are preferred. However, buckets of other types and sizes, and open troughs can be used and will give good results.

Experience shows that where a tube or spout is used for delivering concrete, it is necessary to mix the concrete too wet for the best results. Another objection to this system is that it may be operated like a continuous mixer, the supposition being that, as the spout is provided with blades and revolves, the materials are mixed in the spout. This spout serves only as a conveyor and cannot to any degree take the place of or serve as a mixer.

The mixer should be provided with a suitable automatic water tank which can be quickly filled and emptied, so that when once determined, the required amount of water can be added to each batch of concrete. A number of so-called automatic tanks on mixers are not satisfactory, owing to their limited capacity, delay in filling and emptying, and to the fact that they depend, for successful operation, upon a constant water pressure. Water is pumped on most road jobs, with small gasoline or steam pumps, and it is not possible to maintain uniform pressure in the feed line.

An automatic measuring tank of the required capacity, that may be emptied quickly, connected by means of a comparatively large pipe, with an auxiliary or storage tank of about 50 gal. capacity, would be more satisfactory than the one-tank system commonly used.

Where necessary to keep from cutting up the subgrade and to facilitate moving, the wheels of the mixer should be run on suitable planking. Material of good quality, 3 in. thick by 10 in. wide, in comparatively short lengths with square ends, will be found satisfactory for this purpose.

The power loader or skip should be of sufficient size to hold all the materials required for the batch. In charging the skip a part or all of the coarse aggregate should be placed first, and the cement, fine aggregate, and remaining coarse aggregate, if any, on top of this. All the cement should be in the skip before the last of the aggregate is added. If charged in this manner there will be less tendency for the materials to stick in the skip when emptying and less loss of cement on windy days. A systematic method of loading the skip will also serve as a check on the right amount of material being placed each time.

The filling of the skip is accomplished in practice in two ways—by the use of wheelbarrows and by shovelling direct from the supply piles into the skip. This latter practice, however, should be discouraged, for accuracy is impossible, and it encourages carelessness. Besides, the entire loading gang loses time waiting while the skip is raised and lowered.

Mixing Concrete.—No important operation is given less attention than the mixing of the concrete. Frequently in practice, the time the materials remain in the drum is governed only by the speed of the gang charging the skip. At times the batch mixer is operated practically as a continuous mixer, by fastening the discharge scoop or spout so that there is a constant flow of concrete from the mixer.

The quality of concrete is largely dependent upon thorough mixing. To insure thorough mixing the revolutions per minute of the mixer and the time the complete batch, including water, remains in the mixer, should be specified. To specify either the r.p.m or the time is not sufficient as it is plainly shown by field observations that there is not a direct relation between the two. Upon inquiry of the manufacturers it was found that the r.p.m. of the drum of batch mixers varies for different makes and for different sizes of the same make.

Because of the shape and arrangement of the interior of the drum, the rate at which a given mixer is operated has a direct bearing upon the quality of the concrete; therefore the drum should be operated at approximately the speed at which the manufacturer claims the best results would be obtained.

It is recommended that all specifications contain a clause to the effect that all the materials in any one batch—including the water—should remain in the drum of the mixer at least 45 sec. before any of the concrete is discharged.

In all cases the drum should be completely emptied before the next skip of materials is dumped into the mixer. This is a source of constant controversy between the engineer or inspector and the contractor, especially where the mixer is used equipped with an open trough, or with a boom and bucket when the bucket is not large enough to hold the whole mixed batch.

The operator should start the water into the drum as soon as the skip is in position to dump—that is, it is not necessary to mix materials dry before adding water.

Consistency.—The practice on road work is to mix concrete entirely too wet. This causes a separation of the coarse materials from the mortar, resulting in stony pockets throughout the concrete. Where the concrete is mixed too wet, it is practically impossible to obtain and hold the required crown, and stony patches frequently appear on the surface after it has been finished, owing to the flow of water and mortar to the sides. In striking off and floating concrete mixed with an excess of water, it is also practically impossible to obtain a surface of the desired character, as the excess of water collects in and hides depressions and other inequalities in the surface, which cannot be corrected as they are not apparent until after the water has evaporated.

In addition to the difficulty encountered in getting wet concrete into the pavement in a manner which will give the best results, laboratory tests and results observed in the field show that, other things being equal, a wet mixture is of inferior strength and quality to concrete of a medium wet consistency. The marked effect in the strength of concrete that a variation in the consistency produces, is shown in the tests made in the Sheffield Scientific School of Yale University by Charles J. Robison.

Expansion and Contraction.—As yet there is not sufficient data on which to base a definite conclusion relative to the influence of the consistency of concrete upon the expansion and contraction; however, information at hand seems to show that this action is influenced very largely by the consistency.

Owing to the methods employed in striking off and finishing the surface of concrete pavements, there is little likelihood of mixing the concrete too dry. Concrete mixed with an excess of water is easier to mix, to handle, to place and to finish, than concrete of the proper consistency, which explains the tendencies toward wet mixtures.

The amount of water in the concrete should be such as to cause it to settle to a flattened mass when dropped from the bucket, but not sufficient to cause it to flow readily on the subgrade. The consistency should be such as not to require tamping, but not so wet as to cause a separation of the mortar from the coarse aggregate in handling and placing. If there is an excess of water on the surface, or the mass has a tendency to flow or settle out of position after being floated, the concrete has been mixed too wet.

Placing Concrete.—Just before placing concrete, the subgrade should be well sprinkled so that it will not absorb moisture from the concrete, and should be checked by the engineer or inspector to make sure that the required thickness of concrete can be placed. Checking the subgrade may be done by the use of a straight-edge or line, resting on, or stretched from the top of the side forms.

Probably the most satisfactory method of depositing the mixed concrete in position on the subgrade is by means of a bottom-dump bucket running on a swinging boom free from the mixer. The boom can be swung over any position on the subgrade, and the bucket can be run out and dumped at any point along the boom. Such equipment does not depend for economic operation upon consistency and the concrete can be easily handled and deposited at any place on the subgrade necessitating but little handling with shovels. Between each change in position of the mixer a section, the full width of the pavement (up to 1½ times the length of the boom, and as long as the boom), may be concreted.

When concrete is placed by means of the open trough, care must be exercised to see that it is not mixed too wet, as this method of distribution depends for economic operation very much upon the consistency of the concrete. An open trough is necessarily much shorter than a boom and is more limited in action, which requires that the mixer be moved ahead more often, also that more of the concrete after being deposited on the subgrade be handled with shovels.

When a batch mixer, not having a boom and bucket or open trough, is used, the concrete should be handled in wheelbarrows or hand carts wheeled on suitable runways. Placing concrete by means of horse carts should not be permitted as they cut up the subgrade badly and to get the concrete into final position requires a maximum amount of shovelling.

Whatever the method of conveying and placing, the concrete should be deposited upon the subgrade to the required depth and for the entire width of pavement in as nearly one operation as practical so as to reduce handling to a minimum. If it is necessary to handle a large amount of material with the strike-board it will ride the concrete and thus produce a wavy, uneven surface. Attention to this matter will materially lessen the difficulty and labor in striking off the surface and will result in a very much better finish.

The excess of coarse material that accumulates in front of the strike-board should be uniformly distributed over the surface of the pavement and not left in narrow strips across the section, or placed along transverse expansion joints. An ordinary garden rake will be found useful in distributing the material that accumulates in front of the strike-board. When the strike-board is within 2 ft. of an expansion joint the excess material that has accumulated in front of it should be removed with a shovel and deposited on the subgrade in the next section. Special care should be taken to place good, dense concrete along expansion joints, and all inequalities at the joints, including any small holes left after the removal of the installing device, should be filled with a mortar composed of one part cement and not more than two parts fine aggregate.

The man handling the strike-board should follow closely behind those placing the concrete, for keeping up with the strike-board will materially assist those placing concrete in depositing the required amount of material.

The placing of concrete should be a continuous operation, and stops should be made only at expansion joints. In case the mixer breaks down concrete should be mixed by hand to complete the section, or an expansion joint should be placed at the point of stopping work. Any concrete in excess of that needed to complete the section, when work is discontinued, should be spread out in a thin layer, not exceeding 2 in. in thickness, over the subgrade in the next section and not piled up along the expansion joint.

The strike-board should be cut to conform to the crown of the finished surface of the pavement and should be of sufficient strength and stiffness to show no deflection at the center when supported at the ends, nor a material bowing out of alignment when in use. It should be about 2 ft. longer than the width of the road, protected on the bottom edge with a metal facing and provided at each end with suitable handles.

For roads up to 12 ft. in width two 2 x 6-in. planks, dressed on one side and both edges, spiked together, make a good strike-board, and for roads 12 ft. to 20 ft. in width two 3 x 8-in. or a 2 x 10-in. and a 3 x 10-in., spiked together, will be found satisfactory. Two planks, well spiked together, make a better strike-board and one less likely to warp out of shape than a single piece. The strike-board should not be so heavy that it cannot be easily handled by two men, and to reduce weight and increase stiffness, it is advisable for work over 20 ft. in width to use a strike-board composed of boards 2 in. or 3 in. thick, stiffened by trussing, rather than obtain the required stiffness by the use of heavier timbers.

In striking off a pavement 16 ft. or less in width, where the concrete has been properly placed, two men should be able to handle the strike-board, but for wider pavements the services of a third man will be required to assist in pulling the board forward by means of a drag line fastened at its center.

The strike-board should always be worked forward about perpendicular to the axis of the roadway and as it is moved ahead should be sawed back and forth across the road.

To produce the desired effect will require that the strike-board be passed over the surface of the concrete two or more times.

Though it will be necessary for the workmen to get into the concrete soon after it is deposited on the subgrade, it is desirable that all unnecessary walking in and wading through the concrete be avoided, and under no circumstances should any workmen step upon the concrete after it is first struck off.

Western Builders in Session at Edmonton

Special to the Contract Record

THE Western Section of the Canadian National Association of Builders' Exchanges held their annual convention in Edmonton, February 24 to 26 last. At the opening session, addresses of welcome were delivered by Mr. T. H. Miller, president of the Edmonton Exchange and Mr. W. J. McNamara, mayor of Edmonton. On the morning of Wednesday, February 5, the members listened to an interesting paper on "Reinforced Concrete," given by Mr. J. P. O'Leary, managing director of the Standard Construction Company, Limited, Saskatoon, and also to an instructive paper on "Education in the Building Trades," given by Professor Burgess of the University of Alberta. An important session was held on the afternoon of February 25, when the reports of the various committees were considered.

The special committee reported several important resolutions, most of which were adopted as read. It was resolved that the Association should use its influence to secure legislation looking to the establishment of state liability insurance. Before the adoption of the resolution there was a lengthy discussion of the matter. Mr. Davidson, of Winnipeg, outlined the situation in Manitoba. For two or more years now there has been in operation in Winnipeg a Master Builders Employers' Liability Insurance Association. During this time they have paid out an indemnity for every accident, no matter where the fault. An agreement has recently been reached between the members of the Provincial Association of Builders' Exchanges, the Labor Councils and the Provincial Government, whereby they are about to enact legislation for the establishment of a Commissioner to handle all employers' liability insurance, as has been done by the above-mentioned association. This Commissioner will be authorized to classify all accidents, proportion the mortality, strike a flat rate for all employers, and finally indemnify all victims of accidents. As at present arranged, the indemnity is in proportion to the class of the accident, depending also upon whether the victim is married or single, and upon the number of dependent children.

The Wage Act recently enacted in the province of Saskatchewan was discussed, and it was agreed that the Association was opposed to this act, which provides that all wages must be paid at the end of seven days, allowing no time in which to make up any payrolls, no hold back or lie-over, and preventing the contractor in many ways from securing such tools and other property as his workmen may be using. The Convention was unanimous in condemning the terms of the Act as read. Of late there has been a good deal of agitation in the prairie provinces over the requirement of the deposit of a marked cheque to the amount of ten per cent. of the contract on all Dominion and Provincial Government work, and the Convention resolved to petition the governments and request that in the future a sufficient bond should be substituted. In addition it was resolved to petition all provincial governments to establish technical schools as a part of their education system. The Dominion Parliament will be requested to establish intercommunicating employment bureaus throughout the Dominion. Recently the Montreal Builders' Exchange took action in the matter of asking the government to enact a Dominion Bankruptcy Law, and the Convention went on record as being in favor of such an Act.

While much of the time was devoted to the business of the Convention, the hospitality of the city of Edmonton was enjoyed fully. On the first night of the Convention a banquet was tendered the visitors. At this function there were over 250 persons present. On the next evening there was a very enjoyable smoker. On the last day of the meeting, all were guests of the Edmonton Industrial Association at a luncheon at which five hundred were served.

The final business meeting was held on the morning of February 26, at which it was decided to meet the next year in Saskatoon, the largest city in Saskatchewan. The following officers were elected for the coming year: President, Mr. C. R. Frost, Edmonton; 1st Vice-President, Mr. J. P. O'Leary, Saskatoon; 2nd Vice-President, Mr. James Bourgeault, Winnipeg; Honorary Secretary, Mr. A. M. Frith, Edmonton.

The fourth American Road Congress, and the convention of the American Highway, all its affiliated organizations, and the American Automobile Association, has been scheduled for Atlanta, Georgia, during the week beginning November 9, 1914.

Prospects for a good season in the building trade in Winnipeg are exceedingly bright, according to a statement made recently by Mr. Rodgers, Building Inspector. The records so far are greatly ahead of last year as will be seen from the following figures:—February, 1914, 81 buildings, 73 permits, value $771,700; January, 1914, 89 buildings, 83 permits, value $595,800; total for the year, $1,367,500. February, 1913, 149 permits, valued at $725,800, while for the month of January and February last year the aggregate was $1,107,000.

Montreal Water Conduit—Experts' Findings and Recommendations

Messrs. J. A. Jamieson, R. S. Lea and G. R. Heckle, the engineers appointed to report upon the break in the Montreal water supply conduit, have submitted their report to the Board of Commissioners. Their conclusions and recommendations are abstracted below:

Conclusions

1. That the plans and specifications of the conduit did not call for sufficient reinforcement, nor is the steel properly placed in the concrete section, to provide a sufficient factor of safety, especially in view of the fact that the conduit would be the only means of supplying the city with water during the enlargement of the aqueduct.

2. That in the construction of the conduit the quality of the concrete and the workmanship generally were good, but that the weight and strength of the steel reinforcement was much less than called for by the specifications submitted to us.

3. That the insecurity of the conduit was greatly increased by the proximity of the excavation involved in carrying out enlargement No. 2.

4. That the method of performing the work by means of a heavy drag-line excavator travelling on top of the bank above the conduit imposing a heavy vibrating load concurrently with the removal of the earth which provided lateral support to the conduit further endangered the structure.

The break in the Montreal conduit.

5. That the leakage of water from the conduit is an additional source of danger at points where the conduit is located in easily eroded soil, and the excavation carried sufficiently close to permit the water finding an outlet into the aqueduct.

6. That the failure of the conduit was due to the proximity of the excavation, to the methods employed in the execution of the work, and to the inherent weakness of the conduit itself.

7. That the conduit, as a permanent means of supplying water to the city, is not now to be depended upon.

8. That it would be unsafe to proceed with any further excavation in the earth section on the north side of the aqueduct with the conduit in its present condition and while there is no other water supply available.

9. That it is unsafe to do any blasting in the rock section on the north side of the aqueduct.

10. That it is unsafe to allow the travelling excavators or locomotives or any other similar heavy machinery to be operated on or moved at any point over the top of the conduit.

11. That the reinforced concrete retaining wall as designed by the city and to be built by the Cook Construction Company along the banks of the aqueduct in the earth sections is not, as designed, a safe structure to build for the purposes intended.

12. That a revision of the design of this wall, in order to make it safe, will greatly increase the cost of the project.

Recommendations

1. That before any further work is proceeded with, at least on the north side of the aqueduct, an investigation be made by a commission of engineers into the entire aqueduct scheme, which will include revised estimates of the cost of construction, and the quantity and cost of the power developed.

2. That the city at the earliest date possible make arrangements for providing a new and independent water supply of a suitable character, so located that it cannot be affected by any further accident which might happen to the present conduit.

3. That a permanent cofferdam or intake be at once constructed at the entrance to the aqueduct including proper gates or sluices that may be required, so that the flow of water into the aqueduct may be at all times under control.

4. That until another suitable water supply has been provided the present one should be kept continuously under observation so that in case the present leaks become serious prompt remedial measures may be taken.

5. That the suction pipes of the pumps at the pumping station be lowered by at least six feet as soon as possible so that the conduit may be run partly full or may be quickly emptied.

City Engineer Janin, of Montreal, has issued a lengthy statement in reply to the report presented recently by Messrs. Jamieson, Heckle & Lea. Mr. Janin contends that the conduit is safe and that the construction of a duplicate conduit is unnecessary. He maintains that the accident of last December was entirely the fault of the contractors, who excavated too close to the conduit and below the level of the proposed aqueduct. He recommends that the construction of the emergency intake be carried to completion as soon as possible.

Extensive Harbor Development at Montreal

An extensive construction programme for the next four years has been outlined by the Montreal Harbour Commissioners, and the Government have been asked to allocate $15,000,000 for the purpose. During the current year it is proposed to expend $4,500,000, the main work being the erection of two large warehouses, the elevation of the railway tracks between McGill street and Victoria Pier, and the electrification of the harbour railways. As much of the electrification of the railways as possible will be completed this year. The trackage will also be extended to Pointe aux Trembles, the ultimate terminus being Bout de l'Ile. It is expected that there will be about three-fourths of a mile of the elevated tracks finished this year.

The South Shore bridge, to connect St. Helen's Island and St. Lambert with Montreal, is also recommended by the commissioners. Work on the South Shore this year includes the laying of eight miles of electric railway; a new South

Shore channel to be dredged to twenty feet; and a new industrial wharf at Longueuil for the Armstrong-Whitworth plant. Railway terminals will also be constructed in Longueuil this year the 1,000,000 acres farm of the Government having been deeded to the Commissioners.

Several changes are being made in the Lachine canal. The first two locks are to be entirely removed and replaced by a single standard one-lift lock. Pier number one will be extended to meet an extension of the Bickerdike Pier and will provide accommodation for five additional steamers, and several additions are to be made to the Alexandra, King Edward and Jacques Cartier Piers. The improvement of Victoria Pier is also to be continued and 2,700 feet of high level and 4,800 feet of low level wharfage are to be built. New sheds are to be built at sections 20 and 25, and a concrete pier for the Canada Cement Company at Longue Pointe. Dredging is also to be carried on. Over $800,000 will be spent on elevator No. 2.

Canada Cement Company Optimistic

At the recent annual meeting of the Canada Cement Company, Limited, held in Montreal, Mr. Frank P. Jones, the general manager, gave a few remarks on the outlook for the present year. Mr. Jones stated that at the middle of February, this year's sales were 27 per cent. behind a year ago. However, there had never been a year in the history of Canada and the United States that had not shown an increase over the preceding year in the consumption of cement. The exact output of the company last year was given as 8,913,000 barrels. This was an increase of a little under five per cent. over the previous year, and 100 per cent. over 1909. Regarding the work in view, although as large a consumption was not expected in the West, owing to cement roads and other undertakings under way, the East would most likely show a substantial increase. When asked what danger there might be from United States competition, Mr. Jones replied that cement was cheaper on this side the line than on the other and while it sold at $1.25 per barrel at the head of the Canadian lakes, it sold at Duluth at $1.35 per barrel. As a matter of fact, only 250,000 barrels had come into the country last year. At a meeting of the Portland cement people in Chicago last year, he found more alarm at the prospective invasion of the United States by Canadian cement than in any other feature. Some thirty-five United States plants had gone into the hands of receivers, consequently he did not think that they were going to continue throat-cutting competition much longer. Mr. Jones believed that while Canada was a protectionist country, the government would give the same measure of support to cement as to any other industry.

Mr. J. P. O'Leary, Managing Director of the Standard Construction Company, Limited, of Saskatoon, Sask., who presented a paper on "Reinforced Concrete in Modern Structures" before the Western section of the National Association of Builders' Exchanges, in Edmonton, on February 25th, was born in Quebec in 1859, and has been connected with some of the best known architects in Canada, as Superintendent. In 1895 he built the Place Viger Hotel, the Chateau Frontenac, the Royal Victoria College, all for Bruce Price. Later he went to Texas, where he was superintendent on several hotels for the firm of Burnham & Root, of Chicago. Since then he was superintendent in charge of the construction of the C. P. R. Empress Hotel in Victoria, the Royal Alexandra in Winnipeg, and the Lake Louise Hotel in the Canadian Rockies. In 1909 he was in charge of the buildings for the University of Saskatchewan for Brown & Vallance, of Montreal, after which he went into contracting in the city of Saskatoon. He has been elected 1st Vice-President of the Western Section of the Canadian National Association of Builders' Exchanges.

Personal Mention

Mr. A. F. Macallum, City Engineer of Hamilton, has been elected a member of the American Society of Civil Engineers.

Mr. James Vance, who had been engaged in bridge construction work for many years with the Hamilton Bridge Company, died at New Hamburg, Ont., on February 28.

Mr. H. G. Hunter, Resident Engineer for Canada of the New York Continental Jewel Filtration Company, was recently elected a full member in the Canadian Society of Civil Engineers.

Mr. J. C. Dufresne, M. Can. Soc. C. E., has resigned the position of Field Engineer for Messrs. Cummins & Agnew, of Vernon, B.C., in order to re-establish his private practice at Penticton, B.C.

Mr. Robert Bruce, of Ottawa, Ont., has been appointed successor to the late Mr. George Brophy, as Superintending Engineer of the Ottawa River Works, under the Public Works Department.

Mr. A. M. Bouillon, District Engineer of the Grand Trunk Railway, Quebec City, has been transferred from the Associate class to that of Membership in the American Society of Civil Engineers.

Sir William Willcocks, builder of the Assuan dam, Cairo, Egypt, has promised to attend the convention of the National Drainage Congress, to be held at Savannah, April 22-25, when he will lecture on "River Regulation and Control in Antiquity."

Mr. P. B. Yates, who has been connected with the Ontario Hydro-electric Power Commission for the past five years, has received an appointment as Engineer and Manager of St. Catharines Hydro-electric power system. Mr. Yates takes up duty on March 15.

Hon. Angus McDonnell is at the head of Messrs. McDonnell, Limited, who are associated with Messrs. Grant, Smith & Company, in the contract for new wharves and docks at Victoria, B.C., involving an expenditure of two and a quarter millions. The Hon. Angus McDonnell is the son of Lord Antrim. He was recently married to the daughter of Arthur Jones, the well-known English playwright.

Mr. John O. Brown, C.E., who was a well-known railroad builder, died at the Victoria Hospital, Fredericton, N.B., recently, at the age of 71. The late Mr. Brown had been identified with the construction of several important railroads in Canada and the United States. He built, owned, operated and finally sold out the Northern Railway and was interested in the building of what is now part of the northern division of the C. P. R. in Madawaska County.

Mr. S. Barlow Bennett, for the last two years City Engineer of Nanaimo, B.C., has been appointed engineer of the municipality of South Vancouver. During his tenure of office at Nanaimo, Mr. Bennett has been a frequent contributor to the Contract Record and we join with his western friends in congratulating him upon his appointment to a post which will afford greater scope for his abilities. South Vancouver, we are told, covers 9,000 acres and embraces a population of over 30,000. Detailed mention of Mr. Bennett was made in our issue of December 31 last. Mr. Bennett is an Englishman, a native of Burslem in Staffordshire. After extended experience in municipal engineering in the old country, he came to Canada in 1911 to accept the city engineership of Nanaimo.

MAINLY CONSTRUCTIONAL

*EAST and WEST — FROM COAST to COAST

EASTERN CANADA

At Port Arthur plans are being prepared for a new court house estimated to cost $125,000.

The Bloor-Danforth viaduct for Toronto, on which construction will begin in the summer, is estimated to cost at least $2,500,000.

Building permits issued at Montreal from January 1 to February 28 totalled in value $905,700, compared with $1,106,297 for the corresponding period of 1913.

Windsor records one of the greatest increases in its history and Mr. Brian, City Engineer, states that the permits for March promise to exceed even those of February.

The construction of open-hearth furnaces at a cost of $2,500,000 is contemplated by the Algoma Steel Corporation, Limited, Steelton, Ont. Tenders will be received early in May.

Messrs. Frost & Winchester Company, Detroit, Mich., are the contractors for 100 residences to be erected at East London, Ont., at a cost of $200,000 for the McCormick Manufacturing Company.

The Association of Dominion Land Surveyors held its eighth annual dinner at the Chateau Laurier, Ottawa, on March 3. The function was very largely attended and proved one of the most successful on record.

A private Bill has been presented in the Dominion Parliament on behalf of the Niagara-Welland Power Company seeking a charter to dispose of power that will be developed by the building of the new Welland Canal.

For building activity the present year's total promises to surpass all previous records for London, Ont. Already the building permits are almost double those for the same period of 1913, being $73,270, as compared with $36,855 for the same period last year.

At Hamilton, Ont., operations will shortly be commenced on the Royal Connaught Hotel, estimated to cost $1,000,000. The architects are Messrs. Eisenwein & Johnston, of Buffalo, N.Y., and the general contractors, Messrs. John H. Parker Company, Limited, New York City and Toronto.

The Canadian branch factory of the H. Mueller Manufacturing Company is to be enlarged in the near future to accommodate the steadily growing business of this important addition to the industrial plants of Sarnia. New machinery, including steam hammers, moulding and tool-making machines, have been ordered.

The tender of the Hamilton Bridge Works at $76,625 has been accepted for the steel work and superstructure of the new McKittrick Bridge on King Street west, Hamilton. The McKay-Paulin Construction Company, of the same city, will do the excavating, grading and approaches for $33,794. Exclusive of tiling the bridge and approaches will cost $110,119.

Building operations in Toronto for the first two months of 1914 represent in value about $800,000 short of the total of permits issued in the corresponding period of last year. For February of 1913 the value of permits totalled $1,549,210, as against $1,153,215 this year. The figures for January and February of 1913 are $2,825,294, as compared with $2,048,610 for the present year.

Mr. H. Beauregard, general contractor for the macadamized road which the Quebec Government is building between Charlemagne and St. Augustin, on the north shore of the St. Lawrence, a distance of 152 miles, has announced that at least 60 miles will be completed this year. The contractor has three years to complete the work for which he receives $7,855 per mile.

A new scheme for the widening of Yonge Street, Toronto, has been submitted to the works committee by Mr. Forman, assessment commissioner. The scheme is to widen the thoroughfare on the east side from College to Heath Streets and on the west side from Lawton Avenue to the north city limits, at an estimated cost of $2,000,000. This is said to be a decrease of $1,000,000 over the original scheme.

A detailed inspection of the principal European ports is to be made during the next two months by Mr. W. G. Ross, president of Montreal Harbor Board, Mr. F. W. Cowie, chief engineer, and Mr. M. P. Fennel, assistant secretary-treasurer of the Board. The idea of the tour is to collect data from the most modern European ports to apply to the important programme of the harbor commission for the port of Montreal.

The principal works to be carried out by the Montreal Harbor Commissioners during 1914 include the construction of two new freight and transportation sheds to accommodate the Hamburg-America and Canadian-Northern weekly services; the electrification of the entire system of harbor railways; the elevation of the railway tracks between McGill Street and Victoria Pier, and the building of a large warehouse in Moreau Street.

The J. H. McKnight Construction Company, Limited, has entered suit against the Ontario Good Roads Commission for $14,500 and interest from December, 1912, on account of work of macadamizing the Lake Shore road from Toronto to Mimico. The work was stopped by the cold weather and the commission was satisfied, but payment was not made because the village of Mimico, which was required to pay one-half the cost, has not yet remitted its share to the commission.

Several Ontario municipalities are seeking ratification of by-laws to cover the cost of local improvements.. Fort William, which owns its own street railway, telephone and lighting system, has presented eleven by-laws for approval, calling for an outlay of $8,000 to be used in improving the different municipal services. Lindsay seeks permission to expend $22,000 in improving its drainage system, and the Peterboro' Radial Company want power to increase their bonds from $20,000 a mile to $35,000.

A new factory for the manufacture of wrought steel sash, roof glazing and skylights, has been completed at Peterboro, Ont., for the firm of Henry Hope & Sons, Limited. The structure is of brick and steel, 200 feet long by 180 feet wide, and proves the adaptability of steel sash and sawtooth roof to the modern factory. The building is fitted throughout with carrying tracks and travelling cranes, whilst the machinery for the plant was specially designed and embodies the most modern improvements.

A detailed report on garbage collection and disposal for Toronto, for which the ratepayers voted $1,000,000 in January, 1912, has been presented to the works committee by Mr. Wilson, street commissioner. The report provides for local incineration of rubbish and the disposal of garbage in a combined central plant located at Ashbridge's Bay, with loading stations at the cattle market annex and in the north-western and northern sections of the city for the transfer of material to the central plant, the estimated cost of which is $720,000.

Owing to the growing importance of the construction and maintenance of roads, the Quebec Government this season passed a Bill providing for a portfolio for a Minister of Roads, an office hitherto combined with that of Agriculture, and Mr. Joseph A. Tessier, M. L. A. for Three Rivers, has now been appointed to the new office. The Government have a large road-making programme, and are lending considerable sums to municipalities who are prepared to bear a share of the cost of improved highways.

An expenditure of $2,273,559 during 1914 is recommended by the Harbor Commissioners of Quebec in the annual statement laid before the legislature recently. Of this sum $400,000 will be expended on dredging; $952,029 on extensions to Louisa embankment together with the necessary filling; $108,964 for the purchase of Indian Cove property; $500,000 to provide grain loading galleries in the new grain elevator. These galleries will be of fire-proof construction, capable of delivering grain to ocean vessels at the rate of 40,000 bushels an hour.

The St. Catharines board of trade, comprising about 300 of the largest ratepayers in the city, has passed a resolution expressing its appreciation of the Federal Government for undertaking the construction of the new Welland Ship Canal, as one of the links in a deep waterways system from the ocean to the head of the Great Lakes, and thus to the centre of the North American continent; urging the deepening and widening of the other waterways of the Great Lakes and St. Lawrence route, but endorsing the action of the government in delaying construction of the proposed Georgian Bay Canal pending a recommendation by a government commission composed of men of expert engineering ability.

According to the programme of the Quebec Harbour Commissioners, the sum of $2,273,559 will be spent on improvements this year. The chief item is the extension of the St. Louis embankment, which is estimated to cost $952,000; while dredging a trench for a quay wall and channel approach will absorb $400,000. Other works include railway terminals for extending the delivery yard accommodation, trackage for the new grain elevator, and railway tracks to serve the bulkhead quay wall and an additional freight shed in connection with the car ferry terminals. Grain-loading galleries in the new grain elevator are estimated at $500,000, and the retaining wall at Lampson's Cove for a length of 1,400 feet at the sum of $137,565.

The Department of Labor has issued a statement based on reports gleaned from one hundred localities throughout Canada concerning building operations during 1913. From this we find that the total value of building permits issued is $178,069,838, a decrease of $45,666,639 as compared with 1912. All the provinces, with the exception of Prince Edward Island, New Brunswick and Quebec, show decreases. In these three provinces there were gains of $190,400; $1,843,550 and $2,202,511 respectively. The decreases in the other provinces were:—Nova Scotia, $118,757; Ontario, $1,908,826; Manitoba, $2,608,792; Saskatchewan, $975,115; Alberta, $17,183,007, and British Columbia, $18,408,603. In almost all the big centres throughout Canada building operations reached the high-water mark in 1912. The one outstanding exception is in the case of New Brunswick, where an increase of $1,843,550 over the 1912 figures is reported.

WESTERN CANADA

Humboldt, Sask., is taking tenders for a waterworks and sewerage system estimated to cost $250,000. Bids close April 15.

Mr. A. G. Sangster is putting in the intake for the new waterworks system at Le Pas, Man., estimated to cost $200,000.

Western Pavers, Limited, Winnipeg (Mr. Chas. Curtis, Manager), have twenty miles of concrete walk under contract in Winnipeg.

Calgary University will erect a dormitory building at a cost of $250,000. The president, Dr. Blow, is the authority for the statement that work will commence in the spring.

The contract for the new wharves and docks at Victoria, B.C., has been awarded to Messrs. Grant Smith and Company, and McDonnell, Limited, two Vancouver firms, at $2,244,795.

On the date of this issue, March 11, the ratepayers of Regina will vote on by-laws to raise $360,000 for the extension of the waterworks system, $170,000 for storm water sewers, and $160,000 for the extension of the electric lighting and power systems.

Mr. J. Haddin, Consulting Engineer with the John Galt Engineering Company, Vancouver, visited Vernon recently and made an examination of the sewer system of the city with a view to ascertaining the best way to bring the system up to the required standard.

The Dominion Government are erecting an Immigration Hall and Customs Examining Warehouse in Moose Jaw this year. Work will commence on these buildings early this spring. The Armories, which are being erected at the head of Main Street, are almost completed.

Work on the construction of the Pacific Great Eastern line, between Fort George and Newport, B.C., is proceeding rapidly on clearing and grading, both north and south of Clinton. Work has been commenced already on the building of the first bridge to be completed along the route twenty miles north of Squamish.

In connection with the new water system for Greater Winnipeg, the expenditure upon which is placed at $13,500,000, a number of important contracts have been awarded recently. Of these the most noteworthy is one for the grading and laying of about 85 miles of 60-lb., 4 ft. 8½ in. steel rails, awarded to the Northern Construction Company, Union Bank Building, Winnipeg, at $500,000.

A new building has been erected in Brandon, Man., for the Gordon Mackay Company, of Toronto. It was erected by the Shapley Construction Company, Limited, Winnipeg, and is 150 ft. by 117 ft., being fireproof throughout. In the construction about 4,000 cu. yds. of concrete, 220 tons of steel and one-quarter of a million feet of lumber were utilized. The basement is done in mastic asphalt and the other floors finished in hard metal.

The annual convention of clayworkers of the Province of Alberta was held in Edmonton recently, when the delegates were welcomed by the Mayor. Several interesting addresses were delivered and papers dealing with the clay-working industry were read. A Publicity Committee, for the purpose of advertising and making known Alberta clay products through the medium of trade journals, was appointed, and Mr. J. P. Henry of Edmonton, was elected President for the ensuing year.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Aylmer, Que.
It is understood that the Town Council will do nothing further with regard to the proposed extension to the intake pipe until next January.

Banff, Alta.
Tenders addressed to Lyndwode Pereira, Sec. to the Dept. of the Interior, Ottawa, will be received until April 6th, for the supply of 13,500 lineal feet, 20 in. diameter lapwelded steel pipe, and 12,000 lineal feet, 6 in. diameter cast iron pipe for the water system. Plans are at the office of the Commissioner of Parks, Ottawa, the Chief Supt. Dom. Parks, Edmonton, and the Supt. of Rocky Mountain Park, Banff.

Belmont, Ont.
The town council has under consideration the question of laying cement walks in the town.

Dundas, Ont.
The Public Utilities Commission propose to replace the service iron pipes from mains to houses by lead pipes in the spring.

Estevan, Sask.
By-laws will be submitted to the ratepayers on March 31st, for authority to spend the sum of $3,500 on pipe, valves, hydrants, meters, etc., and $68,000 on the installation of vitrified clay pipe sewers.

Gloucester Twp., Ont.
Tenders will be called in about a month's time for the installation of a drainage system to cost $35,000. $11,000 will be added to this estimate for the construction of culverts and bridges over the cuts. Engineers-in-charge, Stidwell & Magwood, Cornwall, Ont.

The Twp. Council has decided to make certain roadways at an estimated cost of $9,000.

Hamilton, Ont.
A committee composed of Aldermen Birrell, McQuesten and Tyrrell has been appointed to report on the matter of the proposed Kenilworth Avenue subway.

Hullett Twp., Ont.
Tenders will be received by Council Clerk, James Campbell, Londesboro, until 3 p.m. March 27th, for the digging and construction of Bowes Award drain in the Townships of Hullett and Morris. Plans and specifications at the office of the clerk.

Kingston, Ont.
The City Engineer will shortly call tenders for the construction of about 50,000 sq. yds. asphaltic macadam roadway, together with concrete curbing and gutters.

Leamington, Ont.
The town council has plans in progress for the laying of tile sewers. Engineer, G. A. Baird.

North Battleford, Sask.
Tenders will be received by the Commissioners until noon March 16th, for the supply of vitrified tile sewer pipe and cast-iron water pipe. Specifications at the office of the Engineers, Chipman & Power, 47 Canada Life Bldg., Winnipeg, Mail Bldg., Toronto, and at North Battleford.

Tenders for the construction of pumping station, to cost $4,000, will be called by the City Council.

Ottawa, Ont.
Tenders will be received by the engineer, Arch. Currie, City Hall, who will also furnish description of pump and tank required by the Waterworks Dept.

Regina, Sask.
The city council has plans in progress for the construction of a subway on Winnipeg St., at an estimated cost of $90,000.

Tenders will be received by Commr, L. A. Thornton, until March 16th, for galvanized corrugated iron for roofing and siding for filter bed No. 5 at the Sewage Disposal Works. Engineer, F. McArthur.

Sussex, N.B.
The Town Council is considering the installation of a sewerage system, using 30-inch pipe, at a cost of $40,000. Engineer, Grey Murdock, Carmarthen St., St. John, N.B.

Thorold, Ont.
The town council proposes to lay sewers on Pine, Shriner, Battle and Martin Sts. Estimated cost $7,053.23.

Timmins, Ont.
The town council proposes to issue debentures to cover the cost of pavements and sidewalks and additions to the water works and sewerage system. Clerk, Thos. W. Wilson.

Toronto, Ont.
Tenders will be received by the chairman, Board of Control, until March 17, for asphalt pavements on Concord, Dupont, Hartford, Herbert, Mountjoy, Mountalan and Mountnoel Sts., and bitulithic pavements on Brock Ave., Gillard and Mountjoy Sts.

Tenders will be received by the chairman of the Board of Control until March 17th, for sewers on 24 streets. Plans, etc., are at the office of the Commr. of Works.

Tenders close March 17th for the supply of vitrified paving blacks. Specifications, can be seen at Room 12, Purchasing Dept., City Hall.

The following work has been recommended by the Commr. of Works. Material and estimated cost is as specified. Pavements: Conduit St., brick block, $13,979; Connaught Ave., asphalt, $3,375; Humberside Ave., asphalt, $10,665; Conduit St., asphalt, $8,061; St. Clair Ave., asphalt, $11,243; St. Clair Ave., asphalt, $7,244; Balsam Ave., bitulithic, $16,083; Wellington St., asphalt, $20,750. Sidewalks: Blythewood Rd., concrete, $175; Wells St., concrete, $338; Tennis Cres., concrete, $332. Grading: Elmer Ave., $1,887; Beresford Ave., $3,894; Wheeler Ave., $14,979. Roadway: Regal Rd., rocmac, $11,013; Dufferin St., bitulithic, $5,895; Dupont St., asphalt, $19,323; Clifford, asphalt, $5,642.

Toronto, Ont., Newmarket
Tenders for the erection of a post office and customs house will be received by R. C. Desrochers, Sec. Public Works Dept., Ottawa, until March 30. Plans at the Dept., Postmaster, Newmarket, and Station "F," Toronto.

Toronto, Ont., Leaside
The town council proposes to grade 27 streets at an estimated cost of $15,000, and construct concrete roads on McRae Drive and Sutherland Drive, at an estimated cost of $23,705. Clerk, A. T. Lawson.

Vernon, B.C.
A by-law has been carried by the ratepayers to raise the sum of $4,000 for waterworks extension.

Windsor, Ont.
Tenders will be received by W. A. Hanrahan, Sec. Water Commsn., from March 10th until March 27th, for the supply of 500 tons, 6, 8, 10 and 12 in. cast iron water pipe, also valves and hydrants. City Engineer, Ed. Brian.

Welland, Ont.
Tenders will be received by C. M. Webber, Council Clerk, until 4 p.m. March 19th, for the construction of sewers on Fraser, Edward, Queen and Hooker Sts. Plans at the office of the Town Engineer, Welland, and with Hugh C. MacLean, Ltd., 220 King St. W., Toronto.

Woodstock, Ont.
Plans for a sewerage system have been completed by the City Engineer, F. J. Ure, and will be forwarded to the Provincial Board of Health for approval.

Yarmouth, N.S.
The town council is planning to lay 1 mile or more of 12 in. water main this spring.

CONTRACTS AWARDED

Cayuga, Ont.
A contract has been awarded by the Haldimand County Council to Rocmac Roads, Ltd., 74 King St. E., Toronto, for the laying of 26½ miles of roadway.

Frude Mine, Ont.
A contract has been let by the Canadian Copper Co., Copper Cliff, to P. O'Donnel & Co., Sudbury, for the construction of a waterworks pipe line from Whitson Lake.

Kingston, Ont.
The contract for the laying of sheet

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **March 18, 1914** **No. 11**

Principal Contents

The Eloquence of Millions 315
Are Architectural Competitions in the Best Interests of the Profession? 316
Banner Year for Road Work in Nova Scotia 316
The Application of Business Methods to City Government 317
Modern Highway Bridge Construction 318
Engineers as Public Speakers 321
The Protection of Concrete in Sea-Water Between High and Low Tide 322
Cost Accounting Systems for Engineering Contractors. 324
Fairness in Contracts 325
Perco-Filters for Sewage—Diagram for Ascertaining Their Dimensions 326
Lessons from the Sewage-Treatment Plant of Columbus, Ohio. 327
Contractors' Camp for Workmen on the New Quebec Bridge 328
Deck-Girder Bridge with Girder Lift Span, Kamloops, B.C., over North Thompson River 329
Measurement of Gravel in Piles 330
Weight of Crowds on Bridges and Grandstands 330
Test of Flat-Slab Floor 331
Regina's New Telephone Exchange 332
New Arts Building for University of Alberta 332
Protective Measures in Building Construction 332
Warehouse of Revillon Bros., Edmonton 333
Water-Hammer in Steam Pipes 333
Saskatchewan's New Provincial Gaol 334
Concrete in Factory Construction 335
Practical Discussion of Reinforced Concrete Pavements 338
Method of Laying a Concrete Floor 339
New Post Office, Mount Pleasant, B.C. 339
Principles of Efficiency Engineering Applied to Highway Engineering 340
Constructional, Personal and Industrial News 341-346

The Eloquence of Millions

Of all the praise that has been bestowed upon the city of Toronto during recent years, none is more eloquent than the statement that during the next six years no less a sum than $230,000,000 will be expended in engineering and building works classified under six headings.

The greatest expenditure will be under the heading of new buildings. We may exclude the Union Station and estimate that Toronto's average annual expenditure during the next six years will be $30,000,000. This gives us a first total of $180,000,000. Second place is taken by the Harbor Commission's improvements, which will involve the expenditure of $24,000,000. The third place in the list is occupied by the water-front viaduct and the new Union Station, which will cost not less than fifteen and a half million dollars. To the water-works plant at the east end of the city is assigned the sum of $6,700,000, while the amounts opposite the Bloor-Danforth viaduct and the filtration plant additions at the Island are $2,500,000 and $1,300,000 respectively.

These six items, which aggregate $230,000,000, constitute, of course, the greater part of the city's constructional activities—but much remains: there will be a considerable outlay upon sewers, pavements and other work—three sewer systems alone will cost $7,000,000—moreover, maintenance charges upon various public works must be taken into account. Perhaps a fair estimate for the six years would be $300,000,000—an average of $50,000,000 a year.

Such expenditure provides the most convincing argument as to the development of Toronto. And what is taking place in Toronto is going on in lesser or greater proportion throughout the length and breadth of the country, in spite of the recent financial depression. It is of interest to note that the turn-over of Toronto's civic treasury last year was well over $100,000,000, as compared with $40,000,000 in 1909. The Queen City is fast becoming a metropolis—a consideration which should bring with it a measure of gratification to the constructional interests at large.

From the engineer's viewpoint, greater scope for professional ability will be found in engineering works on a greater scale, and from the contractor's viewpoint greater returns will accrue from the same percentage of profit on larger contracts, given the ability to finance them.

As our large cities assume metropolitan dimensions and responsibilities, so they will afford greater possibilities for those identified with their constructional enterprises. Toronto is a conspicuous example of a city that is growing out of a city into a metropolis and carrying with her to success the men who have built her up.

In constructing the deep pressure tunnels of the Catskill Aqueduct for the water supply of New York City many rock fissures had to be grouted. The most difficult piece of work of this kind was at the Hudson River siphon, 1,100 ft. below tidewater. About 150 ft. from the east shaft the heading cut a water-bearing seam, discharging about 300 gal. per minute. The full flow did not develop until the cut was blasted. It then became necessary to grout against a hydrostatic pressure of 500 lb. per square inch with no solid rock to which the grout pipes could be connected. This problem was finally solved by building a concrete bulk-head 8 ft. thick across the heading. The concrete for this bulkhead was of 1:2:4 mixture, and was heavily reinforced with rails set into holes drilled laterally in the sides, roof and floor of the tunnel. Grout pipes leading into the fissure were set through this bulkhead. After the concrete had set for a week grout was forced into the fissure first by the pneumatic process with a high-pressure air compressor and finally with a high-pressure plunger pump forcing water instead of air into the grout tank. Pressures were reached up to 1,000 lb. per square inch.

Are Architectural Competitions in the Best Interests of the Profession?

COMPETITIONS, architectural and otherwise, are defended on the ground that they bring out talent—that they distribute opportunity equally between those who have had the good fortune to come into prominence and those who have not. That there is a certain amount of truth in this argument cannot be gainsaid, but it is doubtful—whatever degree of truth the argument may contain—whether anything can be said to counterbalance the objection to architectural competitions on the score of their cost to the profession. The inspiration for our observations arises out of an inspection of the forty-one sets of designs submitted in connection with the new Masonic Temple building and recently placed on exhibition in Toronto. Here it is fair to estimate the total cost to the competitors at from fifteen to twenty thousand dollars—an amount practically equal to the fee which will be collected by the successful architect for his entire services in connection with the erection of the building! Such an estimate forces one to the conclusion that while competition of a kind may be a good thing and while it may be commendable to try and bring out latent talent, the cost entailed should be the governing factor.

After all, one does not have to look very far for an alternative. In our opinion, by far the better procedure—both in the interests of the profession and of the prospective owners—is to select carefully a man who has shown marked ability to grasp constructive problems of design. In the case of the Masonic Temple building the committee having the matter in hand might have agreed upon such a man and taken him into their confidence. At least one or two of their number might have travelled with the architect to see other buildings of a type somewhat similar to the one desired, the studies having been continued until the solution to the particular problem in hand was arrived at. As it is, the competitors in this competition have been working in the dark—shooting arrows at a venture, and none of them has fully solved the problem. Even the "successful" candidate—the man awarded first prize—has to revise his plans considerably after a careful consultation with the committee.

As a matter of fact the history of competitions, architecturally and otherwise, has not been particularly encouraging. In few cases have even the first awards established a man permanently in the hall of fame. The limelight is turned on for a day and then frequently he is seen no more—not possessing the breadth of vision and experience to meet the demands and live up to the reputation of such a high status.

Competitions might be conducted successfully on a modified scale, perhaps, but the expense entailed in such a case as that cited in this article is altogether disproportionate, and, in our opinion, not calculated to promote the best interests of either the architectural profession or those desirous of obtaining the best ideas that the architectural profession has to offer.

When one reflects upon the system adopted by the Dominion Government in obtaining designs for the new departmental buildings at Ottawa, one is inclined to commend the procedure followed. Sketches drawn to a small scale were invited and from the list of competitors a few were selected for the final competition. These few were all paid for the work.

Architectural competitions are disappointing. Frequently there is disagreement over the sketches and a compromise is effected which leaves the best man out of it. We cannot but think that the rising generation of architects will be better advised to perfect themselves in a skilful blending of the art and practice of their profession by a more direct method than competition affords. Much of the inefficiency found to-day in the architectural profession may be attributed to time wasted in looking for royal roads to success—ephemeral success at best.

Banner Year for Road Work in Nova Scotia

NOVA Scotia is going to have the greatest year for road work in its history, according to details furnished the Contract Record by Mr. W. S. Yorston, Assistant Road Commissioner for the province. It is anticipated that a total sum of $600,000 will be spent in the various sections of the province. The largest expenditure previously made was $400,000 in 1913.

A yearly increase of fifty per cent. will soon place the province of Nova Scotia in the front rank of the road-builders of the Dominion and it reflects creditably upon the authorities, and speaks well for the fulfilment of the optimistic predictions that have been made concerning the maritime provinces, that such enterprising development schemes are under way.

At a time when engineers and manufacturers alike may well be devoting increasing attention to this section of the country it is interesting to learn from Mr. Yorston that of late the annual expenditure on the roads of the province has been upwards of $400,000. One-half of this amount is in the form of statute labor, commuted and uncommuted, and the balance is contributed out of revenue by the government of the province and expended on the roads in the different counties under County Inspectors.

The whole of the road expenditure is administered by the Road Commissioner, with head office at Halifax. A recent amendment of the Highway Act in 1907 provides for the appointment of the Road Commissioner, Assistant Road Commissioner, and the necessary staff of assistants for the proper carrying out of the road work in the province.

Reports of all work required to be done in the different counties are made by the County Inspectors and sent in to the office for approval. If approved of, an authority is issued covering the estimated cost of the work. The responsibility for carrying out the work devolves on the County Inspector, who finally passes the work before the pay-roll is sent in and payment made.

In addition to the assistance given to the roads out of revenue, an Act entitled, "An Act to Provide for the Betterment of Highways," was passed last year. This measure provides for an expenditure of $10,000 in each county of the province, for the betterment of highways. In addition, there was also passed last year an Act entitled, "The Motor Vehicle Act Road Improvement Fund." By this Act all monies paid as license fees by motor vehicles, are diverted to the roads of the province to be applied to the main arteries. The licenses at present paid into the provincial treasury amount in the aggregate to $13,000 yearly.

In addition to the above spending Acts, the Legislature has recently passed an Act to further amend the Highway Act relating to the expenditure of provincial roads and bridge grants. This is an Act providing for the maintenance of the roads by patrolmen. It is only now being put into force, but it is intended to continue the appointment of these patrolmen as fast as organization can be affected. From results already obtained it is thought that this Act will be particularly useful.

Although expenditures under certain sections were commenced in the fiscal year 1913, the bulk of the expenditure to be made under these Acts will come in the year 1914, the necessary surveys and reports for the work having been in large part made preliminary to the starting of the work.

Mr. Hiram Donkin, C.E., Halifax, is Road Commissioner and Provincial Engineer for Nova Scotia. Mr. W. S. Yorston, Halifax, is Assitsant Road Commissioner.

The Application of Business Methods to City Government

By Henry M. Waite, City Manager of Dayton, Ohio.

THE most recent development in municipal administration at Dayton has been the commission-manager form—the application of the business organization of successful corporations to municipal government. In this form we elect our commission, which in turn selects a business manager for the city; he chooses the heads of the various departments. The commission in a corporate organization would represent the executive head or the president of the corporation. In Dayton the organization of departments is on the pyramidal form and is based on five as the ideal number. We have five commissioners as the legislative body who employ the city manager, and under the city manager there are five directors at the head of the five principal functions of government—namely, service, safety, welfare, finance and law. These are selected and appointed by the city manager.

Here is the first and principal application of business methods to city government. Under the old form we voted for the heads of the various departments. It would be just as reasonable to expect a corporation desiring to fill a particular vacancy in its organization to go out and ask the neighborhood to vote on some one to fill that particular place. When a private corporation desires to fill a particular vacancy in its organization it selects the man who it believes will perform those particular functions with the greatest economy and efficiency, and the salary paid is in accordance with his worth to the particular business desiring his assistance, no other ties or conditions being considered.

Dayton elected as commissioners five solid, successful, brought-up-from-the-ranks business men, who in turn employed a manager whom they believed, because of his record, could fill the position. The manager after a careful study of the situation has chosen his directors from material available in Dayton, with one exception.

The director of welfare has charge of health, parks, playgrounds, charities, corrections and social betterment. The man now in office has made this work a study, having spent several summers abroad observing the social conditions in foreign cities, as well as having conducted similar studies in this country.

The director of finance is at the head of the accounting, financial and purchasing departments. The man selected has spent much of his life as treasurer, auditor and in the purchasing departments of manufactories in Dayton, and the latter years have been spent as a public accountant.

The city attorney's duties are self-evident. He is one of the leading attorneys of Dayton, who was willing to sacrifice his own business interests to accept the position.

The director of service has charge of the waterworks, all engineering, contracts, maintenance of streets and sewers, the handling of garbage and ashes, and supervision of all public utilities. The man holding this position has had experience in large construction work and municipal work and was my principal assistant engineer in Cincinnati.

The director of safety has charge of the police and fire departments. This position has not yet been filled, and the duties are being taken care by the city manager.

It is impossible for me to tell you about the political faith or inclination of any of the appointees above mentioned, nor is it possible for me to tell you the political faith of any appointees whom I have named since I have been in Dayton. We simply insist on three requisites—efficiency, economy and loyalty.

In all public work we are confronted with the idea that is grounded in the minds of most men that they do not have to do as much work nor do they have to take as much interest as they do in individual or corporate concerns. Civil service likewise does not produce ideal results from an operating standpoint. But we believe that better results can be obtained under the commission-manager form than under the older forms, due to a more efficient method of selection and removal by the application of our successful business methods to our municipal government.

Patches in concrete pavements at Fond du Lac are covered with a one-half-inch layer of asphalt as soon as laid to protect the surface until it gets its final set. The asphalt will not stay permanently, but will protect the surface for two or three weeks, and as a result one can hardly detect the patches except by the variation in color.

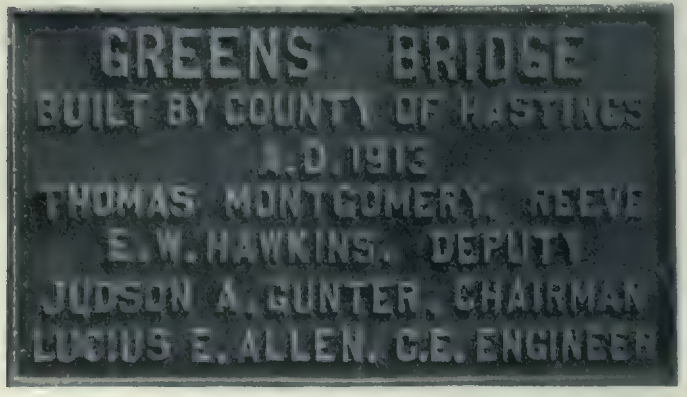
Modern Highway Bridge Construction

Adaptation of Type to Location an Elementary but Important Consideration—Conclusions from the Experience of Hastings County, Ont.

By Lucius E. Allen[*], Belleville, Ont.

BOTH in Canada and the United States public attention is being turned to the importance of good roads. Railway construction has had in the past, and still has, an important place in the development of trade and commerce, but it is now generally acknowledged that the improvement of our public highways is as essential to the growth and progress of the country as the construction of railways, and that with the construction of so-called permanent roads, the construction of permanent bridges bears an important part.

Before referring to modern practice in bridge construction, it may be of interest to refer briefly to the fact that practically less than one hundred years have elapsed since highway bridges—on this continent at least—assumed practical proportions and began to receive the attention of engineers and bridge-builders. The early bridge builders in this country used timber as the material and followed out the types developed by Burr, Palmer and Towne, who introduced the wooden latticed truss, usually covered. Various examples of such structures may yet be seen.


GREENS BRIDGE
BUILT BY COUNTY OF HASTINGS
A.D. 1913
THOMAS MONTGOMERY, REEVE
E.W. HAWKINS, DEPUTY
JUDSON A. GUNTER, CHAIRMAN
LUCIUS E. ALLEN, C.E. ENGINEER

Bronze bridge plate attached to all new bridges by the County of Hastings.

It was not until about 1850 that cast iron was first introduced by Whipple. This material was succeeded some years later by wrought iron. Steel, the material now universally used in steel bridge construction, did not come into general use until about 1875. From its use, due to its great tensile strength, the modern development in bridge construction received its greatest impetus.

The use of cement as a material for bridge construction is of comparatively recent date, although cement was apparently used by the Romans. The first concrete arch was constructed of plain concrete in 1869 and is known as the Grand Maitre bridge, at Fontainbleau Forest, in France. This arch has a span of one hundred and sixteen feet. In 1871 a plain concrete arch of thirty-one feet span was constructed in Prospect Park, Brooklyn, New York. It was not until the construction of a reinforced concrete arch in San Francisco, in 1889, that iron or steel was first used in connection with concrete. At the present time, steel and concrete reinforced with steel are the predominant materials in use for bridge construction.

In the construction of a bridge there are certain essential requirements and principles that must be adhered to in order to secure satisfactory and permanent results. I shall endeavor to outline briefly the fundamental requirements.

Adaptation of Type to Location

There have been many "misfits" in bridges, and one of the first and most important steps in the building of a bridge is a careful study of the location, having special regard to the type of bridge best adapted to the particular location. The main points upon which to base a decision as to the best type of bridge to construct to suit the locality are:—1—length of span and height; 2—character of river or stream; 3—character of foundation.

Whether steel or reinforced concrete have been decided upon, the length of span and height above high water must be carefully considered. If the span be less than sixty or seventy-five feet, a low truss steel construction is usually used; if eighty or 100 feet, the high truss is usually used. It is also essential to consider whether two shorter spans with a pier in the centre are more economical than one long span, which is governed by the height and size of piers required.

The same conditions apply if reinforced concrete construction be desired. Up to 40 to 45 feet the girder beam type of reinforced concrete is usually simpler and less expensive to build than the concrete arch, and it may be possible and more economical to divide the total span distance into a series of reinforced concrete girder beam spans of 40 to 45 feet each.

Character of River or Stream

Due regard should also be given to the character of the river or stream over which a bridge is to be constructed. If the current be rapid, and the water of some depth, the cost of constructing piers in midstream is increased very largely, and the one-span type is preferable. On the other hand, if the stream be shallow and the foundation good, the cost of pier construction is greatly reduced.

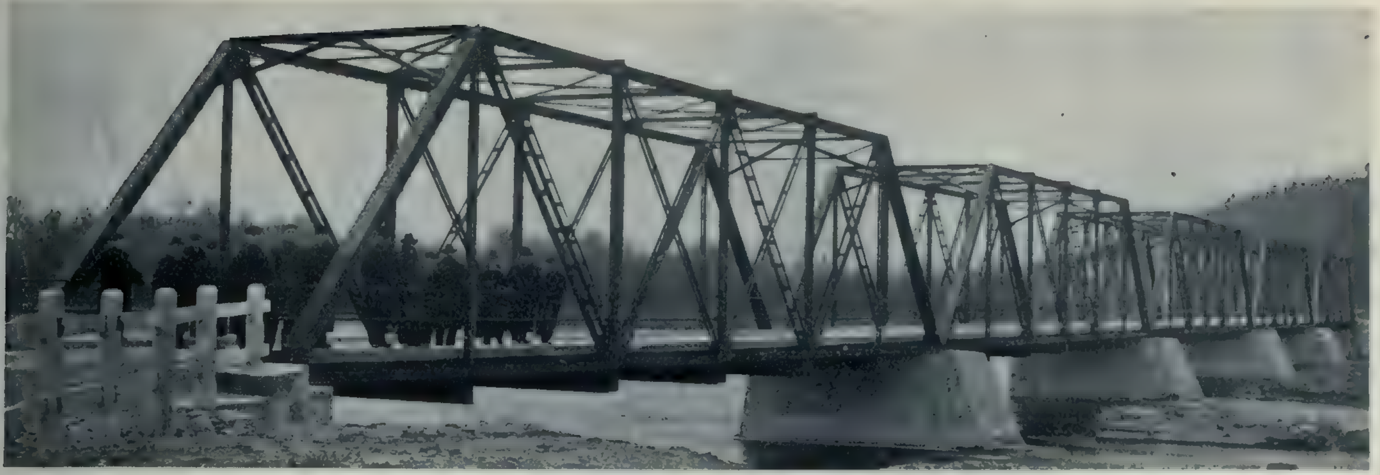
Character of Foundations

In selecting the best type of bridge to build, too much care cannot be given to the character of the foundations available at the bridge site. For important structures it is absolutely essential that the character of the foundation be determined by careful test. This may be done by digging a test pit or by driving iron rods or heavy iron pipe. When these methods do not prove the foundation satisfactory a wash-drill outfit may be used. This consists of a drill point to which is coupled one inch iron pipe in 4-foot lengths. Water is forced through the pipe by a hand force pump, which washes the material up through the pipe.

It is not advisable to use the reinforced concrete arch when the foundation conditions are not of the best. A steel bridge resting on two concrete abut-

---

[*] Consulting Engineer. Engineer to the County of Hastings, Ontario.



Glenn Ross bridge, containing five 95-ft. spans, erected by the County of Hastings

ments, will allow of some movement or settlement of the abutments without injuring the strength of the structure, although it is essential to allow a liberal factor of safety in the size of the footings, so as to give sufficient bearing power to sustain the bridge under maximum load without any settlement.

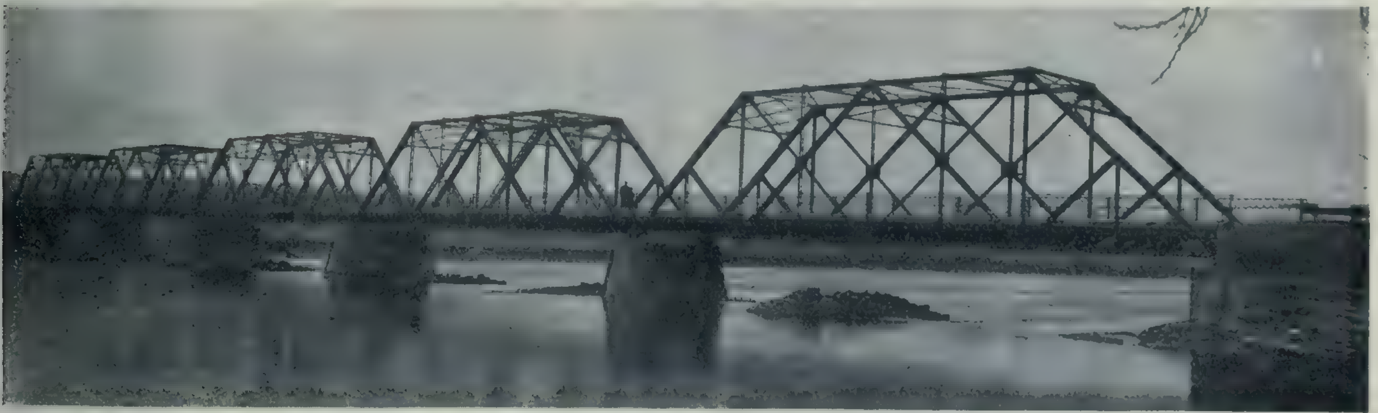
Design and Preliminary Plans

After a careful survey of the bridge site has been made and the character of the foundation determined, it is then possible to decide on the best type of bridge. There are several types of steel and reinforced concrete bridges any one of which may be selected to best suit the particular location. The expression which is heard so frequently these days in connection with the operation of railroads, "Safety First," should apply equally in the designing of highway bridges One factor in the building of municipal bridges which led to the construction of many poorly-designed and weak bridges was the all-too-prevalent custom of allowing each bidder to submit his own plan and design, the result being that the municipality purchasing the bridge, without expert advice, naturally let the work to the bidder submitting the lowest price. This practice, however, has in a large measure disappeared, owing to the requirements exacted by the Ontario Provincial Government, through its regulations and general specifications, under which all county bridges must now be built.

The design and plans for a bridge whether of steel or reinforced concrete should be carefully prepared and checked by the engineer. If the bridge be of steel,

Catholic church bridge, a 45-ft. reinforced concrete arch which cost $1,400.

The Seymour bridge, one 30-ft. span, erected at a cost of $865.



The Frankford bridge erected by the County of Hastings. Total length 500 ft; 16 ft. clear roadway; sidewalk on one side; reinforced concrete floors; approximate cost $39,000.

The Boundary bridge, County of Hastings, two 95-ft. skew spans.

an inspection of the truss and its connections should be made in the shops by the engineer, particular attention being given to the rivetting and painting.

If the bridge be of reinforced concrete, the steel reinforcement should be checked from the plan. During the course of construction a careful check should be made of each bar as it is put in place, as it is evident that after a concrete bridge is once completed there is no way in which to remedy a mistake in placing the reinforcement.

Construction of Bridges by Municipalities

There are two ways in which bridge work may be carried out in municipalities: the first is by letting all work by public contract, the second by organizing a competent construction force under the direct supervision of municipal officials. Where the amount of work is not very extensive and does not warrant the expenditure required for machinery and equipment necessary for carrying out the work, the contract system is probably the better; but where the work is sufficiently large the county-operated system, in my opinion, is the better system. As the County of Hastings has developed this system to a large degree, I shall outline its development and method of operation.

At the beginning of the year 1910 Hastings County had some 250 bridges, nearly all of them being old wooden structures. Several of these bridges had failed, killing a number of people and costing the county large sums for damages and repairs. On the adoption of a report presented by the Chairman of the Roads and Bridges Committee in 1910, the present system of bridge construction was inaugurated. The pro-

COUNTY OF HASTINGS

Daily Report of Bridge Construction

To Lucius E. Allen, C.E.,
County Engineer,
Belleville, Ontario

Report No.........
Date........... ...
Bridge............
Post Office........
....

I beg to Report as follows as to progress of work for day ending ... ... 191 ....

1 Total Number of Men Employed ... ...
2 Total Number of Hours for day ... ...
3 No. of Laborers Employed ... ...
4 No. of Carpenters and helpers ... ...
5 No. of Teams Employed ... ...
6 Total amount of Pay Roll for day, $ ... ...
7 Estimated amount of Excavation or Fill ... ...
8 If Cofferdam or Pumping is required, state to what extent ... ...
Cement ... ...
9 Proportion of Concrete, Gravel ... ...
Rubble ... ...
10 No. Batches Concrete as above ... ...
11 No. Sacks Cement used ... ...
12 No. Barrels Cement on hand ... ...
13 Quality of Gravel or Sand ... ...
14 Condition of Weather and Temperature ... ...
15 State nature and general progress of work for day ... ...
... ...
16 Information or material required ... ...

... ...
Foreman

County of Hastings—Daily Progress Report.

An old structure which the County replaced last year by a reinforced concrete arch.

Glenmire bridge, consisting of three 45-ft. spans erected by the County of Hastings.

gramme of construction, as laid out, being a large one—involving an ultimate expenditure of nearly $500,000—methods of handling the work economically and efficiently were essential. The following general plan has been followed.

At the beginning of each year, an inspection is made of those bridges that appear to be the most dangerous to public safety, and the year's work is subsequently laid out. The council, appoint, at the beginning of each year, a special Bridge Committee which is in direct touch with the work through its Chairman and engineer. The actual construction work is carried out by several gangs of men, each of which has a competent foreman who is held responsible for the hiring of the men and their general efficiency. The Chairman and the Engineer make frequent inspections of the work as it progresses. The foremen are required to make a daily report in writing to the engineer covering the essential details of the work, materials or information required, and at the end of each month the engineer checks the payrolls from the daily reports for the preceding month. During the year 1913, six bridge gangs were employed. Each gang is supplied with a complete camp equipment, which reduces to a minimum the so-called "high cost of living" of the men. A complete equipment of the necessary machinery is provided. This equipment consists of three Wettlaufer half-yard concrete mixers, concrete wheel carts, pumps, excavating tools, etc.

Local material is used when it can be secured of the right quality. The superstructures of all new steel bridges constructed within the past four years have been designed to meet Class "C" of the Provincial Government General Specification. The substructures for steel bridges are constructed by the county bridge gang. The plan followed in calling for tenders for steel bridges has been for the engineer to prepare the required plans and submit these to all companies tendering, so that uniformity in design has been secured. Reinforced concrete floors have been specified in all cases and have proved very satisfactory, requiring no repairs. In most cases a surface covering of 4 to 6 inches of gravel has been put on the bridge floors over the concrete. This protects the concrete and also tends to hold the snow in winter better than a smooth concrete surface.

The form work for reinforced concrete bridges is made up from two-inch lumber surfaced on one side and two edges, and is used at least twice. Portland cement is distributed in car lots to the nearest railroad station. During the year 1913 over six thousand barrels were used in bridge work.

In the past five years, in Hastings County, sixteen steel bridges, with approximate total span length of over 3,000 feet, have been erected at a cost of some $155,000, and forty reinforced concrete bridges, with a total span length of approximately 1,900 feet, have been built at a cost of some $83,000.

Conclusions

There are several essential points in the construction or planning of highway bridges which should have the careful consideration of municipalities having work of this nature in view.

1.—Each year a municipality should make a careful examination and survey of all bridges, with regard (a) to their safety, (b) to their state of preservation and repair, and (c) to the character and amount of traffic in each case.

2.—A systematic plan and organization of the work required to be done by the county or municipality should be made in advance, before any public catastrophe, due to bridge failure, can occur.

3.—The execution of such work should be delegated by the municipality to a competent official whose engineering qualifications and experience are a guarantee of proper and efficient construction methods.

4.—After a bridge has been constructed, especially if the superstructure be of steel, great care and attention should be given to the preservation of the structure by keeping it properly painted at regular intervals.

5.—Before proceeding with the design and construction of a bridge, future traffic conditions should be considered. The length and height of span above present high water should also be taken carefully into account. Many bridges have been destroyed owing to changed conditions of the water run off in streams and rivers, due to the denuding of our forests and the clearing up of water-sheds.

Engineers as Public Speakers

THERE is no oratory so potent as sincerity, no rhetoric so effective as simplicity, and no logic so persuading as marshalled facts, says Engineering and Contracting in a well-considered editorial discussion of the above topic. The fundamentals of the art of public speaking, says our contemporary, are possessed by most engineers when they speak on engineering subjects. But practice must be had in this art as in every other, if greatest effectiveness is to be attained. We urge all civil engineers to join local engineering clubs and societies and to practice discussing engineering subjects at the formal meetings of such organizations. Why, indeed, may not the old debating society methods be adopted? It is said that many of the orators of the West, of which Bryan is perhaps the most illustrous example, learned their art in country town debating societies. While engineers will not seek to emulate some of the methods of the orators thus trained, is it not likely that engineers could greatly profit by adopting the underlying plan of the old-time debating society?

Incidentally there might spring from such debates a public interest in engineers not otherwise obtainable.

Suppose, for example, a question had arisen as to the desirability of purchasing a water works owned by a company. Suppose the local engineers' club were to announce a debate on the question, naming, say three engineers on each side. Is it not probable that the debate would be well attended by the public? Is it not certain that the local press would report the debate fully?

Engineers are now prone to "let George do it"—George being the lawyer—whenever there is to be speaking on public matters. It is amusing, in spite of the serious side, to an engineer, to listen to the ordinary lawyer or politician address an audience on any topic of an engineering nature—roads, for example. Who of us has not smiled, and yet sat ill at ease, while such a man tried to make a Patrick Henry oration on "good roads"? Yet, if we engineers will not speak to the public, perhaps it is well that some one should speak, even if the speech be ridiculous in connection and ornate in delivery.

Every engineering college should teach public speaking and should give its students much practice in the art. There can be no serious discord on this point. But we who have graduated without such training, have had to teach ourselves, as best we could, how to talk in public. This self-teaching, after all, would not be so difficult if only it were possible to get sufficient practice. And it is with the idea of securing practice that we have suggested the debating society.

Larger debating clubs of engineers might profitably employ an instructor in elocution. But even if no outside instructor were hired, one or more members of the club should "coach" the speakers. Few men are good originators but few are poor critics.

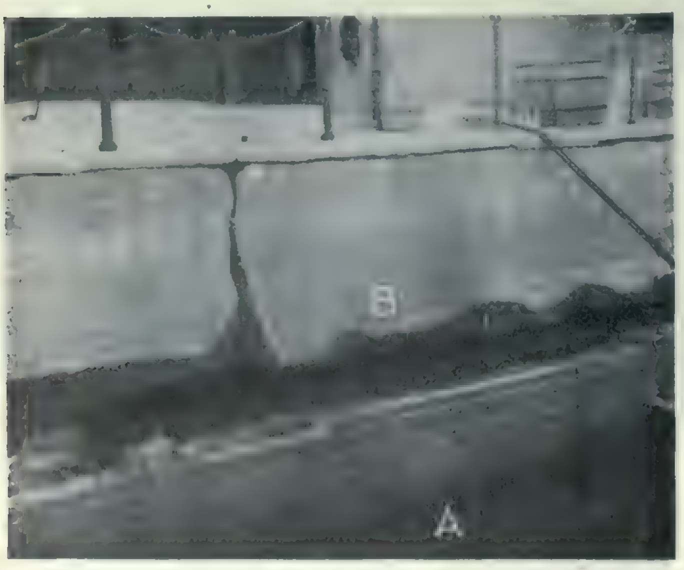
As a youth the writer was a member of a debating society that solved all, or nearly all, the political problems that had baffled American, and indeed the world's statesmen. It is true that even yet some of the most noteworthy decisions of that society have not been written into statutes. But it is equally true that several members of that society reached high political positions, largely by the "political pull" of a rugged "nerve" and strong vocal cords, aided by a bit more than the average of intellectual ability.

Politics, however, is not the aim of many engineers, when politics means divorce from engineering. But the majority of civil engineers are in politics to the extent that they are dong public work. Even railways and other public service companies are fast becoming parts of the great social machine that is under the control of public servants. We are entering a new engineering era, and with the change there will come increasingly greater opportunities for the civil engineer in public service. Indeed, may we not witness—sooner than perhaps seems now credible—the election of many engineers as chief magistrates of cities and states, with ultimately a return to first principles, namely, the election of a civil engineer to the presidency of the United States?

The Protection of Concrete in Sea-Water Between High and Low Tide

By William B. MacKenzie, C.E.*, Moncton, N.B.

THE accompanying view shows a typical example of the deterioration of concrete in sea-water when exposed in the intertidal space to wetting and drying, freezing and thawing in northern latitudes. The rate of destruction between A and B in the photograph was ½ to ¾ of an inch a year after about the third year. This wall has been twice repaired. The first time the repairs were made with vitrified bricks, but they were not carried up high enough and the waves reached above them. It was repaired further in 1911 by adding four tiers of small concrete blocks, of cement one, sand two, set in air. The vitrified bricks have remained in perfect condition. The concrete blocks set in 1911 are already showing signs of damage. The quality of the concrete below low-water and above high-water is first-class. I have observed that where sea-water is mixed with fresh water, to the extent of, say, fifty per cent., as at the mouths of rivers, or in arms of the sea projecting far inland, the rate of destruction is considerably greater than in sea-water alone.



An example of the destructive effect of sea-water upon concrete in the intertidal space.

The system of protection patented by the writer and described herein consists of a combination of vitrified salt-glazed hollow clay tile blocks (built in with the concrete structure) which form an outer shell to protect the inner concrete structure from contact with the sea-water or the atmosphere, and which completely protect it from frost and wave action. The blocks are pressed through a die, in a manner similar to the ordinary building blocks, but they are of greater thickness. Further, they are finished with large openings in the sides and ends, so that the wet concrete runs into the blocks by gravity, as they are built up into a wall slightly higher than the mass of concrete which they enclose. Usually the block wall forms the mold for the concrete body, iron tie-rods being used to prevent the block wall from spreading while the concrete is wet. When completed, the blocks become an integral part of the structure and the whole presents the appearance of a tile block construction, as shown in figures 7, 8 and 9.

Fig. 1 is a top plan of two tile blocks, placed end to end and kept in line by grooves and tongues at D. B B are holes in the ends and sides of the blocks to allow the wet concrete to flow into the blocks by gravity, concrete can also be put in directly from the top. C C are the tie-rods which prevent the blocks from spreading by the pressure of the wet concrete. The rear and end walls, and the continuous concrete connections in both directions, lock the blocks into the concrete body so that there is no possibility of separation. It is known that cement adheres very strongly to a tile surface, no matter how smooth it may be.

Figures 2, 3, 4, 5 and 6 show the details of the blocks and also the closing pieces which are to be used when walls are built with battered ends.

The blocks can be made of any desired dimensions, but they are usually eight inches by eight inches by sixteen inches. The walls of the blocks can be made of any desired thickness, but two inches, for the front

---

*Right of Way and Lease Agent Intercolonial Railway of Canada.

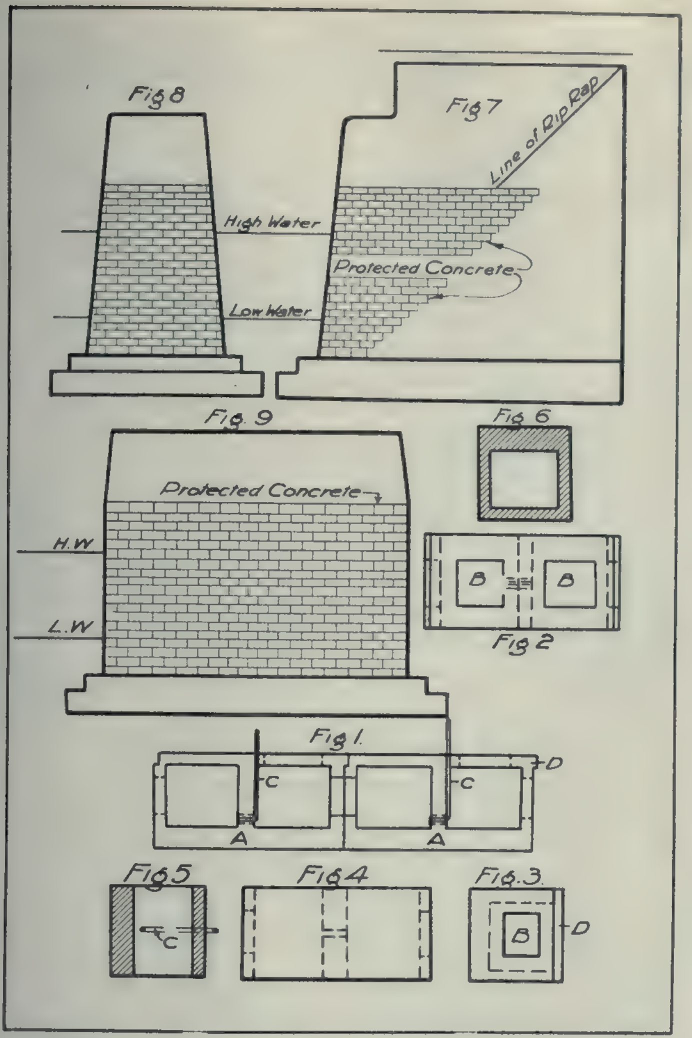


Fig. 1-9. Protection of concrete in sea-water.

and middle wall and one inch for the back and end wall is sufficient.

A thoroughly vitrified and salt-glazed block which has been subjected to a furnace heat of 2,400 degrees Fahr. is as impervious to water as a china tea-cup and is not affected by sea-water, alkali, acids or gases. It cannot possibly be affected by frost or alternate wetting or drying.

The 1907 Committee Report of The American Bridge and Building Association, as a result of careful examination of many concrete structures in sea-water, draws attention to the unsuitability of concrete for use between high and low tide. Many other authorities have reported numerous cases of damage in similar situations and leading construction engineers are now either using granite or covering the concrete with wood.

Many of the concrete bridge piers on the railways and highways along the Bay of Fundy shores are encased entirely in wood, while some of the more important highway bridge piers over large rivers in fresh water are being built either wholly or partially of granite, much of it being transported long distances, although sandstone quarries exist in the vicinity. A large concrete pile wharf for ocean steamers now under construction has a part of the concrete piles covered with wood. On the Atlantic Coast, a large ocean terminal, to cost many millions, is designed with granite facing. Even on the Pacific Coast, where very extensive ocean terminals are designed, concrete is barred in the intertidal space.

The cost of the vitrified tile blocks is a mere fraction of the cost of any concrete structure. For the exposed face it is very much cheaper than granite. No one can successfully dispute the indestructibility of vitrified tile.

Scientific Management

In publishing elsewhere in this issue an abstract of a lecture on Scientific Management delivered at Columbia University, we believe that we are providing our readers with several points worth turning over, but we cannot fail to recall the editorial criticism of the subject launched some two years ago by our contemporary, The Engineer, of London, England. The following is an extract from the editorial in question:

> "Anyone who studied for a few months the engineering papers of America would come to the conclusion that the worst managed shops in the world were those of the United States. Paper after paper contains articles on shop management, on scientific management, on the Taylor System, the Gant system, bonus, premium and piecework systems, on the use of card indexes, on route cards, on shop costing, and so on, and so on, ad lib. The continual striving for something different implies discontent with existing things, and we are thus led to the conclusion that the Americans themselves deem their systems bad and unsatisfactory. A man in perfect health takes no interest in his internal mechanism; he is not continually overhauling it, patching, mending and altering it; he is so well satisfied with it that he forgets its very existence, and it is only when he becomes conscious of it that he knows he is unwell. The American works manager appears to be continually conscious of his organization. There seems to him always to be something wrong with it, and he is for ever trying new experiments on it."

Another Problem for the Water Analyst

The responsibilities of the waterworks field are rendered greater by the fact established by recent official investigations in the United States that cancer, one of the most malignant and most dread diseases, is water-borne. Of 19 trout hatcheries examined, evidences of cancer were found in all. That only trout grown artificially have the disease and that cancer is regarded as non-contagious, are facts which only provide food for deeper reflection. The Engineering Record discusses the matter editorially in part as follows:

> "Transmitting cancer by means of water is not a new theory, but what are the details of the transmission? Is there an intermediary host—bacteria which an infinitesimal cancer bacterium infects? Perhaps the chemical residuums of life and the very care which domestication involves tend to reduce, as in humans, that power of producing sufficient opsonin or resisting force to the attacks of the numerous disease germs to which the human economy is continually subjected. At any rate, the subject is of such vital interest that analysts will no doubt be glad to co-operate with those already in the field searching for preventive means of transmitting cancer. Possibly some one has already tried filtering and chlorinating the water, carrying cancer to the last pond in the series noted. Should this or any other chemical water treatment prove beneficial the fact would be of tremendous import to the waterworks field."

Cost-Accounting Systems for Engineering Contractors

OWING to the diverse conditions under which the many branches of engineering contractors have to work, a system of cost-keeping that will be applicable to all contracts must be expansible and simple in its detail. An attempt to explain such a system is made by a special committee of the American Society of Engineering Contractors in a recent report.

Many systems have been under consideration, but a large number of them are more suitable for a factory than for an engineering contractor in actual contract work in the field. Some of them are so intricate and involved that the very cost of maintaining them on the job would be a considerable item to be charged against the profits and in many cases would be prohibitive.

An elaborate system of cost keeping can be utilized in a factory where there is usually a fair number of skilled workmen among the employees, and a clerical force among whom the work of collecting and tabulating the records can be apportioned; in fact one is now likely to find in a factory, men who will take pleasure in keeping up a record card. While in the field the good foreman is usually more adept with the pick than with the pencil and he sees that the work proceeds, but neglects the record.

A system that will meet with the demands of a small contractor must be one that can be applied by the man himself—his superintendent or timekeeper, and usually the man who is most adapted to look after the cost keeping is the timekeeper, who should be thoroughly capable and trustworthy; in fact, the proper keeping of the field notes depends largely on the personal ability of the timekeeper to consign to each employee his place on the daily record.

An important feature to be carefully provided for is the proper identification of every individual workman by some distinctive means—usually a number—and a brass check or badge is assigned to him with his number stamped upon it. Where a large number of men are employed, a badge that can be pinned on to the cap or the outside garment is very desirable, but in most instances the brass check is the favorite method employed.

His check is given to the employee in the morning and returned by him to the office at the end of his shift. This makes a check upon his presence on the job at those two times, and his attendance at the work is verified by the timekeeper at regular intervals throughout the day.

The check should be kept on board panels and should be arranged in numerical order. The panels can be readily made to fold together and be locked up, thus keeping the records of each shift intact and separate from the other shifts.

The checks should be assigned to the workmen in groups somewhat along these lines, which of course will vary with every contract:

Office force and foreman	No. 1 to 20
Carpenters and helpers	No. 21 to 50
Machinists and helpers	No. 51 to 80
Hoisting Engineers	No. 81 to 100
Laborers	No. 201 to 400

In this way each workman can be immediately placed in his proper group as soon as his number is known.

When a number has been assigned to the workman a white cardboard check should be hung on his hook, which should be made out as per sketch:

JOHN DOE
217 Blank St.
Toronto
Laborer 20c.
Started Dec. 31st.
Disct.

This gives the timekeeper a record that is often of value in case of accident. On many jobs workmen are only known by a number and in case of a fatal accident it is almost impossible to properly identify him. On the reverse of the cardboard check the age and name of nearest relation can be placed, and this card can be saved even though the man has been discharged, until the end of the job.

Each contractor should decide for himself to what degree of refinement he wants to keep his records, and should outline certain heads which can be further subdivided later on. For instance, the item of plant, and its removal from the contractor's yard to the job and its return to the yard again might be put under one head (Plant) and assigned a number 1. Many contractors would be satisfied to keep that expense by itself

DISTRIBUTION OF CARDS .... JOB

DATE	1—PLANT		2—TEMP. BLDGS.		3—HAULINGS		4—EXCAV. EARTH		5—EXCAV. ROCK	
1914	Labor	Materials	Labor	Materials	Labor	Materials	Labor	Material	Labor	Materials
Jan. 1										
2										
3										
4										

The labor amounts are daily recorded in the book and explanations for materials are similarly recorded on the day of payment. Each column is added daily, weekly or monthly as suits the convenience, but by keeping the additions made up from day to day it is possible for the contractor to know exactly where he stands or any one on all items.

while others would want it sub-divided into, say, loading at yard, hauling to railroad and loading on cars, freight, unloading at job, and in that case would give each sub-head a number, 1a, 1b. 1c, etc. Plant erection and dismantling are often placed under No. 1, while others might prefer to have a separate item.

Temporary Buildings.
Unloading and hauling of Materials.
Excavation of Rock.
Excavation of Earth.
Building forms for Concrete.
Erecting and dismantling forms for Concrete.
Mixing and Placing Concrete.
Miscellaneous Work.

The above items may be used as a start for a system of cost keeping. The daily time distribution sheet used by the timekeeper would be lined out as follows:

DAILY TIME REPORT FOR.............

No.	Rate.	Time.	Amount.
	....		
	....		
	....		

The workman's number in column No. 1
" " rate " " " 2
" " time " " " 3
" " amount due " " " 4

In the other columns the head spaces are left blank so that any number or item can be written in by the timekeeper, it being preferable to use a number, then the record is more private than if the name of the item is used. Thus: 1 at the head of the column might with one contractor mean plant while with another it might be assigned to excavators. The workman's time is checked off under the various headings or items at which he is employed during the day. These hours must agree with his full day's record and the sum of the several columns for all the workmen must balance the time on the amount column each day.

The time keeper's record is handed in daily and recorded in the office book, which is columned out so as to provide a column for each item, and each item column is divided into two parts, one for labor and one for material, as per sketch.

Instead of completely tearing up the old macadam roads to replace them with more modern construction where motor traffic has made their maintenance prohibitive in cost, the authorities of Allegheny County, Pennsylvania, are preserving these old road surfaces by using them as a base for new concrete or brick roads. Mr. J. S. Gillespie, County Road Commissioner, in addressing the American Road Congress at Detroit, stated that for brick roads the macadam is first scarified and formed to a true cross-section, concrete curbs are built, the sand cushion is placed, and the brick are laid, after which the surface is grouted with a mixture of equal parts of sand and cement. In the other class of construction, bituminous concrete is laid directly upon the scarified and levelled surface, and both finished surfaces are rolled. The method is said to be economical and satisfactory.

Fairness in Contracts

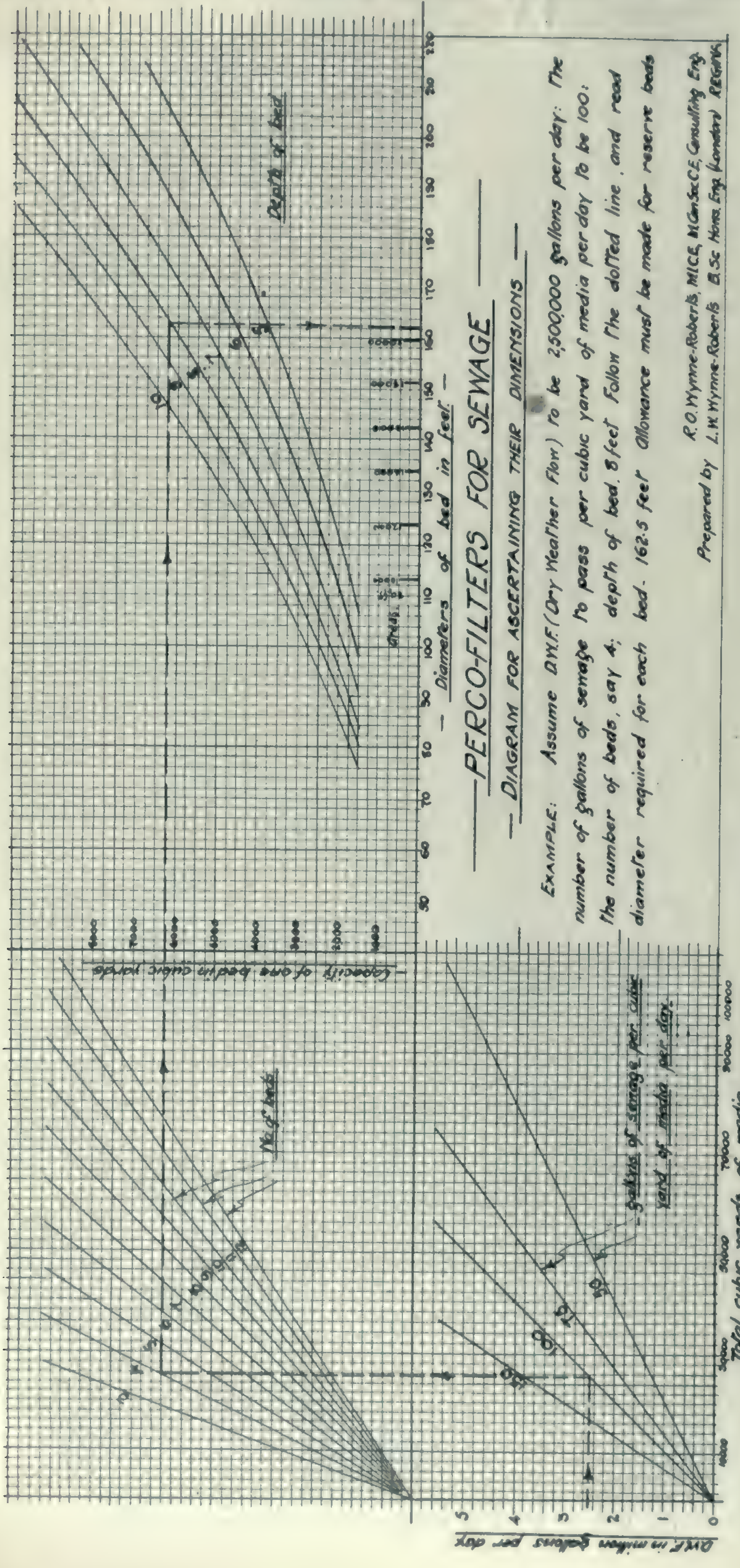
WE recently expressed an opinion of the unfairness to contractors of too many municipal contracts, and a paving contract which we have just examined serves as a further illustration of the point; also of the use of irrational units, says The Municipal Journal.

This contract in the first place requires that proposals be made on the basis of the square yard of finished work, including not only grading, ballasting and paving, but also special work under and around the ties of railroad tracks in connection with the foundation, the curb, the removal of "all obstructions such as trees, stones, blocks, etc." The only way in which the contractor could bid on work of this kind by the square yard is to estimate first the entire cost of the work and then divide this by the total area of pavement proper, running the risk of not only erroneous calculations but also of false assumptions or guesses as to the amount of trees, stones, etc., to be removed and the relative proportion of curb and special track foundation work to pavement proper, with the disadvantage that an error either way is against him, in that it either causes him to bid too low and thus lose money or to bid too high and probably fail to get the contract. The uncertainty is increased by the fact that the street railroad is to be given the opportunity of paving in the track area if it desires, but otherwise this work shall be done by the contractor.

Care is taken to specify that the city shall not be liable in any manner to the contractor for any damage to him or loss due to any rock, water, sand, or any other unforeseen construction or material which he may come across in the work. Also that the city is not to be liable for any extras of any kind or nature unless these are ordered in writing. The city reserves the right to increase or decrease any part of the work indefinitely; also places on the contractor any loss which he may sustain owing to delay forced upon him by any cause whatsoever, not even allowing an extension of the time of his contract unless he immediately give notice to the city in writing of the cause of the delay. Finally, payment for the contract is to be made in special assessment certificates which the contractor is to receive in payment for the contract at their face value. Even if there were no other loss to the contractor, he is required to leave with the city a bond in the sum of forty per cent. of the contract price, the interest on which sum he loses directly or indirectly.

With all these risks forced upon the contractor apparently the only opportunity left open for a loss to the city is by the failure of the pavement, the contractor not being under a maintenance bond. The specifications are good, and if the work is in charge of an engineer and inspector who know their business the city will probably obtain a good job. If the work moves along without any unforeseen difficulties, if the quantities constructed are approximately those indicated on the plans, and if the engineer and inspector are reasonable and men of experience and common sense, and if the contractor has figured correctly and allowed for a fair profit in making a bid, then the chances are that both he and the city will be satisfied with their contract. But, if any of the conditions above named should develop otherwise during the construction, then the contractor is very apt to be a loser, and the only loser—unless he can take it out of the city without their knowledge; and contractors are only human—most of them very much so.

Perco-Filters for Sewage—Diagram for Ascertaining their Dimensions


—PERCO-FILTERS FOR SEWAGE—

—DIAGRAM FOR ASCERTAINING THEIR DIMENSIONS—

EXAMPLE: Assume D.W.F. (Dry Weather Flow) to be 2,500,000 gallons per day: the number of gallons of sewage to pass per cubic yard of media per day to be 100: the number of beds, say 4; depth of bed 8 feet. Follow the dotted line, and read diameter required for each bed. 162.5 feet. Allowance must be made for reserve beds

Prepared by R.O. Wynne-Roberts, M.I.C.E., M.Can.Soc.C.E., Consulting Eng. L.W. Wynne-Roberts B.Sc. Hons. Eng. (London) REGINA.

Depth of bed
— Diameters of bed in feet —
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
Areas
— Capacity of one bed in cubic yards —
No. of beds
— gallons of sewage per cubic yard of media per day
— Total cubic yards of media
D.W.F. in million gallons per day
0
1
2
3
4
5

By R. O. Wynne-Roberts, Consulting Engineer, Regina, and L. W. Wynne-Roberts, B Sc. (Hons. Eng., London), Regina

THE designing of sewage filters may appear a simple matter, but it often occurs that there are certain conditions which govern their arrangement, dimensions, etc. For instance, in one district, the fall may be very slight, and deep filters are not possible without pumping operations; in another district the fall may be great, and reasonably deep filters will economise the area of land required. Between these extremes there are numerous conditions to be considered.

In this article it is not proposed to discuss the advantages and disadvantages of deep and shallow filters; these may be dealt with in a future contribution. There is, nevertheless, a minimum and a maximum depth of filters to obtain the most efficient results, both financially and bacteriologically, and the engineer will be well advised, when designing sewage filters, to fully consider this matter.

The question is often asked what size filters are required to perform a certain work. Before an answer can be made, due consideration must be given to, and much will depend upon, the strength of the sewage, the efficiency of the settling tank, and the size and material of the filtering media.

The diagram accompanying this short article has been designed to meet practically every condition, and for all dry weather flow up to six million gallons a day. The capacity of any filter per cubic yard of filtering media may be anything from, say, 50 to 150 gallons a day; there may be any number of filter beds, say, from 3 to 12, and their depth may range from 5 to 10 feet.

When the engineer has selected any one of these factors, he has simply to trace a line from the dry weather flow column clockwise, as described in the diagram and the final figure will be the diameter of a circular percolating filter. The engineer may reverse the procedure, however, and arrive at the daily dry weather flow. The diagram is simple and self-explanatory.

Lessons from the Sewage-Treatment Plant of Columbus, Ohio

By Rudolph Hering*

THE receipt of the annual report of the Sewage Disposal Division of the City of Columbus, Ohio, for 1913, by C. B. Hoover, suggests a few remarks, in view of the facts that the Columbus sewage disposal plant is the first large plant of its kind in this country and that the experience gained by it is, therefore, especially valuable, and most strongly emphasizes the directions in which progress is being made.

When the Columbus problem was studied in 1901, I recommended septic tanks followed by intermittent filters, because this treatment, among the several treatments then known, was the best. Caution, however, was also recommended and the advice given a year or two later that certain experimental investigations be made, in view of the economical phases of the sprinkling method of treating liquid sewage, then being developed in England. It was especially necessary to make such investigations on account of the much colder winters in our western climate. The results caused the local authorities to adopt septic tanks and sprinkling filters, which later were detailed and built.

Mr. Hoover in his last report gives a very good summary of the present condition and states his conclusions for future work.

The operation of the filters has extended over a number of years. Sprinkling filters have proved to be an economical success even in severe winter weather. At the present time it is reported that the river is seriously polluted with raw sewage and trade waste, extending for over 15 miles. Foul odors, gastification and floating sludge are present at times within a zone, the boundaries of which are determined by the dilution, the oxygen in the river water and the temperature. In consequence of this, Mr. Hoover recommends "the installation of additional and improved treatment facilities." A number of lessons may be learned from this case.

(a) With a seemingly recommendable disposition, both communities and their engineers are too often inclined to curtail the cost by planning works, either with too small a margin for the natural growth of a city, or with a feeling that in the near future new solutions would require extensive alterations in any works at once to be built.

The first reason for keeping expense down should be strongly opposed by engineers because history pretty consistently shows that unless a city outlines and persists in following a definite plan of extending its public works, they may soon become insufficient their expenses increased and the former troubles repeated, sometimes with unfair reflections upon the engineers.

The second reason, regarding new solutions in embryo, is more difficult to handle. A city may be compelled to seek some relief at once and cannot wait any longer. The engineer must recommend a definite plan. If he has good cause to believe in the early birth of a better plan, he stands before two alternatives. Either he should at once report his belief and the grounds for it to his client, who then assumes the responsibility of action, or in the absence of such belief at the time when his recommendations are adopted, he should report any new discoveries or developments to his former clients, as soon as he is fully convinced that the art has materially improved in the designs or constructions which he had previously recommended. If engineers act conscientiously and courageously under such circumstances, respect for and confidence in the members of our profession would correspondingly rise. The responsibility for further action then again rests with the clients and not with the engineer.

(b) While engineers a few years ago considered the septic tank a "necessary evil," they now generally consider it an unnecessary evil, to be replaced by some method of inoffensive sewage disposal as soon as practicable. Where no septic or ordinary settling tanks exist, the installation of the inoffensive but deeper two-storey tanks is generally easy. But where large areas are already covered by the shallower septic tanks, as in Columbus and many other cities, the solution is more difficult. This at present is an instance of an expected early birth of a plan to supplement such single and shallow tanks which will secure inoffensive decomposition and sludge.

(c) The building of final settling basins for the Columbus filter effluent did not then seem necessary to me, because the septic sludge was intended to be, and until recently was, flushed at flood times into the same river which received the filtered effluent at all times. I did not recommend such final basins for Atlanta because the effluent from the filters carries less suspended matter than the river water which was to receive it. Mr. Hoover reports the improvement of the sprinkler effluent as affected by the final settling tanks to be only eight per cent. with respect to its stability value, which is the value to be considered for a discharge into river water not soon used for a potable supply.

Unless the effluent discharges into a stream always having clear water, I believe that money for such final settling basins can be better spent by still further oxidizing the effluent water than is usual before it leaves the filters. Nonputrescent suspended matter from a good sewage filter when entering a brook or river is no more objectionable in quality than the solid matter which is usually washed into the same by a rain storm from agricultural lands.

(d) Mr. Hoover further says, that where gastification was noted in the river, sludge deposits were found, and also says that odors were never detected in the Scioto River at such points where there was any residual dissolved oxygen, and even the entire absence of oxygen was not always accompanied by odors.

The sewage-treatment works, according to Mr. Hoover, were in service 61 per cent. of the total time and 97 per cent. of the time from May 17 to December 31. Mr. Hoover, therefore, very properly urges additional installations.

Sludge deposits in rivers cause the rapid abstraction of dissolved oxygen, even to its entire disappearance, with the subsequent condition of putrescence and of nuisance caused by the generation of sulphureted hydrogen. If there were any need for further evidence, which in my opinion there is not, the Scioto River at Columbus again clearly indicates the objectionable result of sludge deposits. We can improve many of our rivers at and below cities discharging raw sewage into them, simply by removing the sludge deposits and getting clean bottoms, both near the shores and in the docks, as well as in the beds. I believe that in time river cleaning will be considered as desirable as street cleaning.

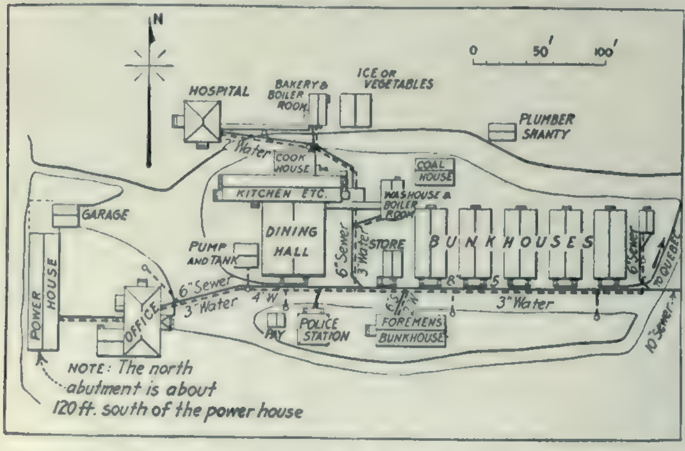
---

* Of Hering & Gregory, Consulting Engineers, New York City, writing in the Engineering News.

Columbus' experience once more verifies the opinion of many, that offensive odors do not arise from sewage-polluted rivers, if their water still contains residual oxygen, and that it is unnecessary to spend large sums of money to oxidize liquid sewage on land wherever it can be oxidized in running water in such manner that at no time and at no points the dissolved oxygen in the water will be depleted. The latter condition positively secures the absence of a nuisance, as evidenced not only at Columbus but at many other cities. The question of water-supply, of bathing, of fish life and of agriculture, where they arise, must be answered on a different basis from that of a nuisance.

Contractors' Camp for Workmen on the New Quebec Bridge

THE camp of the St. Lawrence Bridge Company, Limited, at Quebec Bridge, described by L. G. Jost in Engineering News, is situated near the north abutment of the bridge, on a natural plateau which slopes gradually toward the east. It is protected on the north by a wooded hill and on the east and south by a low ridge of rock. As the bridge site is about half a mile from the main road, three miles from a street-car line, and eight miles from Quebec, and as the housing facilities in the neighborhood were inadequate, it was necessary to build practically a complete village. This was commenced in August, 1912, on land leased from the National Transcontinental Railway.



Lay-out of St. Lawrence Bridge Company's Camp at Quebec Bridge

The plan gives a general layout of the camp, including the water-supply and sewerage systems.

There are five bunk houses, each 24 x 53 ft. in plan and comprising eight 10 x 10-ft. bedrooms and a 12 x 24-ft. sitting room in front. The inside partitions are of single sheathing 8 ft. high; each room contains two two-tier bunks. A large stove in the living room with a pipe running the full length of the building provides heat in winter. The bunk house of the foreman is similar but has nine smaller sleeping rooms and a bathroom.

The common toilet is at the east end of the camp, and is 11 x 18 ft. in plan with sloping concrete floor which may be hosed out. It contains two range closets; and the automatic flush tanks are kept warm in winter by coils from a jacket heater. The 17 x 30-ft. wash-house building contains 18 porcelain wash basins and six shower baths. At the rear is the boiler room with a low-pressure boiler from which housed pipes are run for heating the dining hall and kitchen.

The dining hall is a bright room 47 x 58 ft. in plan; the roof has a slope of 1 on 12, and is carried on six 15-in. 42-lb. I-beams resting on 8 x 8-in. posts on sides and center. It has a seating capacity for about 150 men.

The kitchen building is two storeys high, the upper being used as office and bedroom for the camp steward and quarters for the culinary staff. One end of the ground floor is a storehouse for dry groceries, while the other end is a cold storage room (heretofore cooled by ice, but now by an ammonia plant).

The cooking is done in an 18 x 30-ft. addition at the rear. The steam cooking utensils are operated by a high-pressure boiler in a house at the rear. This boiler also supplies heat for the hospital. The latter is a 24 x 28-ft. building and contains an office and bedroom for the resident physician, and one ward with bathroom, etc. It is intended only to administer first-aid treatment. All serious cases will be removed as soon as possible to the Quebec hospital.

The office building is a two-storey structure 28 x 53 ft., with a one-storey wing 20 x 20 ft. used as a draughting room. The interior of the building is sheathed. On the second floor there are seven bedrooms, a bathroom and a living room; in a small concrete cellar, there is a low-pressure steam boiler.

Other buildings not mentioned are a garage, a small pay shack, a general store, coal house, plumber's shanty, stable, police station, and bungalow for the superintendent and the engineer in charge of construction work.

Water is supplied to the camp by an artesian well. The water is pumped to a 10,000-gal. tank on a 40-ft. tower. Five 3-in. fire hydrants take care of the entire camp. At each hydrant is a small hose house containing two 50-ft. lengths of fire hose. The vitrified sewer mains range from 6 to 10 in. in diameter, and with the water line are buried about 2 ft. deep and follow the natural slope of the ground, which gives a gradient of from 3.5 to 0.5 ft. per 100. At the outlet the sewage runs into a 10 x 10-in. wooden chute and is carried over a bluff to a point below high-water level, some thousand feet downstream from the bridge.

The camp is lighted electrically by current transmitted from Quebec. Should this supply fail, the company's power house is able to carry the lighting load.

New Deck Girder Bridge of Canadian Northern Railway over North Thompson River, Kamloops, B. C. (Bridge 1209 ft. long. Lift span 93 ft. long, with 55 height of lift.)

Deck-Girder Bridge with Girder Lift Span, Kamloops, B.C., over North Thompson River

A RAILWAY bridge of unusual proportions at Kamloops, B.C., carrying the Canadian Northern Railway over the North Thompson River, is described by Engineering News. The structure is a deck-girder bridge, 1,209 ft. long, and has a deck-girder lift span 93 ft. long. There are 12 fixed spans, also of 93-ft. length. Approaches at both ends of the bridge, of timber trestle construction, total about 1,100 ft. The bridge was designed by Messrs. Waddell & Harrington, of Kansas City, Mo.; the lift span is built with the arrangement and details used by them in their various lift bridges built in recent years. In this structure the lift span weighs 118 tons, and is fully counterweight. The sixteen 1¼-in. lifting cables are equalized in the attachment to the span. Centering casting provide for keeping the span in proper alignment as it comes down to bearing, and also take the longitudinal braking thrust. The lift of the span is 53 ft., giving a 55-ft. clearance above high water. The motor is capable of raising the span in 100 seconds. The lifting power is a gasoline engine, which, with all the machinery except the operator's levers, is located below the deck, at the middle. Limit switches coming into operation near the ends of travel of the span control the igniter circuit of the engine.

Breakwater Construction

IN a recent report the Harbour Improvements Committee of The American Society of Engineering Contractors recommend that in constructing rubble mound breakwaters the stone used should be paid for, preferably by the short ton of 2,000 pounds, as this is usually more satisfactory for all parties concerned than when the cuft or cuyd is used. Especially is this true where the stone is hauled direct from the quarries on scows as gauges can be placed in the scows and the load displacement quickly and accurately determined. When concrete superstructures are built, the superstructure, of course, should be paid for by the cubic yard.

As winds and rough seas are prominent factors to be considered in breakwater construction, the time for completion of a contract should be extended for a reasonable length of time before applying a penalty in cases where work has not been completed in the prescribed time, owing to unfavorable weather conditions alone, and not delayed for other causes that could have been avoided. The bonus and penalty plan, while a good thing in most kinds of construction work, cannot always be satisfactorily used in breakwater and pier construction.

While it is considered to withhold a portion of the money—usually 10 per cent.—due for work done to insure the completion of the contract, it is also considered advisable to accept and pay in full for the portion of a breakwater that has been satisfactorily completed, provided a considerable portion of the remainder of the work is at least half completed. The portion to be accepted and paid for in full when completed should not be less than 25 per cent. of the whole.

This acceptance and paying in full for parts of contract work that has been completed, should apply to the construction of piers and docks as well as breakwaters.

Ice Jam on Fraser River Wrecks Bridge Falsework

Sweeping down the Fraser River in British Columbia last month, an ice jam carried away 250 feet of falsework which had been erected for the Kettle Valley Railroad bridge at Hope. Work on the substructure was begun about two months ago and the falsework had been extended 750 ft. from the south shore. Above Hope the river had been tightly packed with icefloes which had drifted down from the upper reaches of the Fraser, and when the temperature dropped suddenly the whole mass commenced to move. The contractors had foreseen this occurrence and one of the costly open caissons which was ready for launching was saved by being secured behind a breakwater. All the men on the work were warned in time to escape, but part of the falsework went out and in so doing precipitated into the river two hoisting engines, a derrick and a concrete mixer. After some difficulty all this equipment was salved and is reported not seriously damaged. The contractors, Messrs. Armstrong & Morrison, of Vancouver, B.C., still hope to complete the substructure before high water, which is due about May 1. The bridge is to be a double-deck structure supported on four 238-ft. spans.

Measurement of Gravel in Piles

By Oliver Clark

IN purchasing, selling and excavating gravel, there seems to be a growing tendency among contractors, public officials and others to have the gravel measured in the pile as soon as convenient after it has been excavated. The immediate measurement enables the parties to know the approximate quantity so that they can arrive at an immediate settlement, and the gravel can be hauled away without the trouble of keeping account of the number of loads.

The greater number of these piles are taken from wet pits and located on comparatively level ground. The usual method of excavating is by means of an endless chain or dredge, and the manner of excavating has much to do with the shape of the pile. The more regular the pile, the more easy it is to measure it accurately.

Probably no two engineers use exactly the same method in measuring gravel piles, nor are any two piles exactly the same shape. Before attempting to measure a pile I view it carefully and determine what mathematical figure it most nearly approaches or can be made to approach by cutting the same into sections. Where the sides of the pile have a very steep incline, so that the taking of horizontal and vertical measurements would be difficult, I usually take the angle of inclination of the sides at the base and the distance up the incline, from which the horizontal and vertical distances can be computed trigonometrically.

Some piles will most nearly approach a cone, usually with an elliptical base, the area of which can be obtained by getting the major and minor axes. The quantity can be calculated by cutting the pile into quarters, taking the angle of inclination and the slant height from all four sides, and then computing trigonoemtrically the horizontal and vertical distances. The sums of the horizontal distances obtained from opposite sides will give each axis. The average of all four vertical heights will give the average height of the cone, at the same time taking into consideration the difference that may be in the level of the ground at all four points of the base.

If the pile should take the shape of a frustum of a cone, set a stake in the middle of the top, so that the highest point will be the vertex, and calculate as before, taking the extended volume from the result. If the pile has curved sides from top to bottom, it will be necessary to cut it into sections (parallel to the average level of the base) and calculate each section thus obtained as a separate frustum of a cone or a prismoid, using the prismoidal formula.

The most general form of pile is oblong with steep sides curved from top to bottom, coming so nearly to an apex as to be easily extended, and having elliptical ends. My usual method in measuring such a pile is to first cut off each end by a vertical plane at right angles to the main axis of the pile, then divide the remaining middle portion into three or some multiple of three sections (depending on the regularity of the pile) by vertical planes at right angles to the main axis of the pile, so that when the area of each cross-section is obtained, the entire middle portion can be calculated as one or more prismoids.

To get the area of each cross-section, take the angle of inclination and the distance up the incline for each course in going up the pile from the base to the top (the end of each course being so taken as to correspond to the greatest break in the slope of the side of the pile), and from the data thus obtained the horizontal and vertical distances can be computed trigonometrically and the sections divided into triangles and trapezoids and the area obtained.

The end sections can be calculated as half the frustum of a cone with an elliptical base, one axis of which will be the bottom width of the end cross-section and the half of the other axis will be the horizontal distance from the end cross-section to the extreme end of the pile at the base, running in the same direction as the main axis. The method of obtaining the cubical contents of these end half cones will be the same as in the first case described.

If the pile be low and spread out over considerable ground so that the horizontal distances can be easily measured, it may be cut vertically into squares, say 10 ft. each way if very irregular or 20 ft. if regular. The elevation of each corner of the squares, as well as the elevation of the ground at the base should be taken by a levelling instrument. The average elevation of the ground at the base should be obtained by taking elevations at equal distances around the base in such a manner as to average the high and low points as nearly as possible. The average level of the base thus obtained, taken from the average level of all four corners of each square, will give the vertical height of the prismoid whose end is that particular square. From these data the cubical contents of each prismoid and the cubical contents of the entire pile can be computed.—Engineering News.

Weight of Crowds on Bridges and Grandstands

The Impossibility of Customary Load Requirements

THE question of the weight of a crowd on bridges and other structures has been the subject of numerous controversies, and the requirements made by the Local Government Board and various public bodies in this country are sufficient to show that available data have not been so fully appreciated as could be desired.

In an article contributed by Dr. Ing. Bohny, to Centralblatt der Bauverwaltung, it is stated that an almost universal practice is to take the weight of a crowd at 420 kilogrammes per square metre (92.16 lb. per sq. ft.) on the roadway of a bridge, and at 550 kilogrammes per square metre (112.64 lb. per sq. ft.) on the footpaths, the author adding that "technical literature is mute as to the origin of these figures."

It may be presumed that they embody the results of experiments made in closed chambers with a compact and immobile crowd, and which are quite inapplicable to bridges in actual use. As values for the weight of crowds covering large areas are lacking, it is interesting to study the following carefully determined recent figures given by Dr. Bohny.

Taking the average weight of a person at 60 kilogrammes (132.3 lb.) it is evident that 7½ persons per square metre would be required to realise the load of 450 kilogrammes. In British units this involves nearly 1½ persons on every square foot, a moment's consideration sufficing to demonstrate the absolute impossibility of squeezing people so tightly together, save by hydraulic pressure or some process analagous to that employed in the packing of sardines.

In order to arrive at anything like a true idea of the compactness of a crowd, it is necessary to count the number of persons occupying an area of known extent. Mr. Kunz, formerly chief engineer to the Pennsylvania Steel Company, and builder of the Blackwell Island Bridge, New York, has given the results of two investigations of this character, the weight per person being taken at 132 lb.

The first determination was made at Coney Island, on a bridge where a dense crowd of people had assembled to watch an exciting spectacle on the water below. Having counted the number of persons, and measured the space occupied by them, Mr. Kunz found the load to be less than 13½ lb. per square foot, or from one-eighth to one-thirteenth of the loads frequently demanded by the Local Government Board and various authorities in this country.

The second observation took place on the upper deck of one of the large ferry steamers plying in New York harbour, these vessels, like street cars, suburban railways, and all other means of transport in New York, being customarily packed to overflowing. Nevertheless, Mr. Kunz found the average load to be only 26 lb. per square foot.

These practical figures differ materially from the theoretical values cited. They are sufficient to show that crowds representing an average load of 30 lb. per square foot must be of very exceptional occurrence on bridges, and to prove the utterly unwarrantable nature of specifications insisting upon such unattainable values as 1 cwt. or 1½ cwt. per square foot for the weight of a crowd on bridges.—Ferro-Concrete.

Test of Flat-Slab Floor

By W. A. Slater, Engineering Experiment Station, University of Illinois

THE first floor above the basement in the new factory of the Shredded Wheat Company of Niagara Falls, N.Y., was tested recently. This is a three-storey reinforced-concrete structure of the flat-slab type, divided by columns into 20 x 22-ft. panels. The floor is 7 in. thick in the central portion of the panel and 9 in. throughout the area of 8 ft. 6 in. square surrounding each column, and is designed to carry a live load of 125 lb. per square foot. The columns are octagonal in shape, those of the basement storey being 25 in. in the short diameter and ending at the top in 3½-ft. flared heads. The columns of the storey above are 23 in. in the short diameter. The reinforcement, all of which is placed in the two directions parallel to the sides of the column, is designed to resist positive moment at the centers of all spans and negative moment at the columns and across the edges of all panels.

Originally nine panels were loaded to 191 lb. per square foot, after which the load was removed from six panels, leaving three adjacent central panels loaded. These three panels lie in a row and are one span removed from the exterior wall of the building. Finally, the load was removed from all but the central panel of the entire test area, where it was increased to 243 lb. per square foot.

Deformations were measured at 288 gauge lines and the results were very consistent among themselves. It was found that the condition of the three adjacent panels loaded gave steel stresses at the center of the span more than fifty per cent. greater than with nine panels loaded, and that the stress at the support was about twenty per cent. less with three panels loaded than with nine. It seems apparent that the tendency of the floor to deform as a cylinder instead of as a saucer, its action as a continuous beam and lateral distribution of stress to unloaded portions of the slab all contributed to these differences between the stresses under nine-panel load and those under three-panel load. The results of the test seem to check the conclusion arrived at analytically—that the greater portion of the unbalanced moment was carried by the columns and very little by the slab. This conclusion is somewhat in conflict with the observation that there was so great an increase in the stress at the center of the panel when only three panels were loaded. In this respect it is typical of the generally observed fact that the results obtained from such tests are usually indicative of the general trend of results, but cannot be applied too rigidly as final conclusions.

Regina's New Telephone Exchange

REPRODUCED herewith is a photograph of the new telephone exchange building at Regina erected at a cost of nearly $100,000. The telephone system is government-owned and the building was erected by the Saskatchewan Government. The dimensions are 85 ft. by 75 ft. and the construction is fire-proof throughout. The walls are built of Twin City brick with trimming of Bedford stone. The framework is of steel and the floors are of concrete. The main offices and the main halls are of tile. To eliminate the noise nuisance, which is always one of the disagreeable factors in buildings of this kind, cork composition is used in the floors. The main entrance is trimmed with stone and is surmounted by the crest of the Saskatchewan Government, carved in the same material. The interior trim throughout the building is of oak. The main entrance leads into a public hall 19 ft. by 40 ft., off which are situated general and private offices. The automatic system installed at Regina is very elaborate and the telephone equipment is complete in the minutest detail.

New telephone exchange building, Regina, Sask. Architects: Messrs. Storey & Van Egmond; contractors, McKay Construction Company.

In the basement are located the power, heating and ventilating plants, all of which are of the most modern type. In connection with the generation of power, the possibility of a suspension of the telephone service has been adequately guarded against by providing what is virtually a power plant in duplicate, as it will be possible at any time, on a moment's notice, to transfer the "load" over to the city power. The plant in the exchange building consists of a 50 h.p. Diesel engine, which burns crude oil; a 30 kilowatt electric generator; two 30 h.p. electric motor generator sets (one as a reserve); a central switchboard for controlling, converting and distributing the electric current, and motors in various parts of the building for driving the ventilating fan and bell ringing devices, and for lighting signal lamps.

In connection with the ventilating system, the air, on entering the large intake pipe, passes through steam coils for heating, then through a spray wall of water to cleanse it from all impurities, and lastly through another coil of steam pipes, this time to be dried. An exhaust fan at the top of the building draws out the foul air. In order to protect the delicate mechanism of the automatic switches, the large switch room has been fitted with double glass windows, and is virtually dust-proof.

Messrs. Storey & Van Egmond were the architects and the McKay Construction Company the contractors, both local firms. Messrs. Storey & Van Egmond were also the architects for the new power house at Regina, erected at a cost of $425,000, and described in the Contract Record for November 26, 1913.

New Arts Building for University of Alberta

By Edward C. Mason.

THE contract has been let and the work of construction commenced in Edmonton for another large building for the University of Alberta. The new structure is the Arts building, and marks another stride towards the completion of the group planned four years ago. The main wing will be 300 feet long by 70 feet wide, with a rear wing for an auditorium 60 ft. wide and 93 ft. long. The building will be three storeys high, with an attic storey for the draughting rooms. The exterior will be red face brick, with stone trim, and a terra cotta parapet to match the limestone trim below. The outer walls will be furred with 3-in. terra cotta tiles, and all partitions are to be terra cotta blocks 4 in. thick.

Proposed Arts Building, University of Alberta. Architects: Messrs. Nobbs & Hyde, Montreal.

In the basement will be the University press, a library with stacks, locker rooms, and a mining and testing laboratory. The approach to the main floor will be through a vestibuled entrance with marble pavement and granite steps, into the main hall, which will have quarry tile floors, ornamental terra cotta wall finish, and ornamental ceiling. The main floor will contain the Common room, a reading room, four class-rooms and three lecture rooms. On the second floor will be the Faculty room, the President's room, Geology and Mining laboratories; three lecture rooms, three class-rooms, offices and committee rooms. The hallway will have quarry tile floor, with terra cotta walls and vaulted plaster ceiling. The Faculty room is to be elliptical, 25 ft. by 33 ft., and two storeys in height with ornamental plaster walls and ceiling, oak floor and trim, and marble fireplace. On the third floor will be the Chemistry and Physic laboratories, also a Biology lecture-room and Research laboratory. In the attic store at either end will be a draughting room, provision being made for two others in the centre. The roof will be a saw-tooth skylight over the draughting rooms, and also over the laboratories below. In the wing there will be a large assembly room, with lobby, stage, and organ, besides gallery and dressing rooms. The basement of this wing will be used as a fan room and storerooms. Hot air heating from a central plant will be installed.

The Architects are Messrs. Nobbs & Hyde, of Montreal. Prof. Cecil S. Burgess, of the Department of Architecture of the University, will act as Resident Architect. The contract for the building has been let to the Fuller Construction Company at $428,000.

Protective Measures in Building Construction

IT is unnecessary to protect form work from the rain, as usually it is possible to get only green lumber, its tendency being to shrink out of shape rather than swell. Rough concrete never need be protected from the rain before setting, only from the concentrated run-off over some portion of the work which might wash deeply the cement out of a small area.

A troweled finish, however, must be protected against being pitted by the rain or damaged by concentrated streams. This is usually done by tarpaulin, which consists of 12-oz. cotton duck rendered waterproof after being made into covers 20 feet square. These are supported by a temporary frame. They are somewhat of an inconvenience to the finishers, and decrease the amount of work which they can do.

If rain is expected, it is usual to delay work until after the storm is over, if possible; otherwise, to build a shelter. Sudden showers require quick decision whether there is time to build a shelter, and also its cost, as compared to making repairs on the surface if left exposed. As a rule the shelter is built.

Protection From Sun

If there is to be an unavoidable delay in placing concrete after forms are erected, it is best to protect them from the sun if possible, because they shrink so as to open up cracks which permit the mortar to escape, leaving a bad surface on the concrete. Rough concrete does not require any protection from the sun, with rare exceptions. It is usual to cover up a granolithic finish for at least five days. The materials most available and most economically used for this purpose are rough bags, such as come around bales of cotton or wool, shavings, sawdust, and sand. The object of these is to retain the water which is put upon the surface to keep it wet and to maintain it at a fairly uniform lower temperature than direct sun action permits while setting.

The writer considers it unwise to spray bare concrete in the hot sun, and the use of roofing paper is but little better, because it retains moisture but a very short time. The water falling on a surface heated directly by the sun chills it suddenly, causing it to shrink, and may cause the very cracks which one is trying to avoid.

Protection from Frost

The aggregates must be free from frost when mixed. A live steam pipe can be shoved into the sand pile, the escaping steam heating it and removing all frost. The same may be done with the stone, but a canvas should be thrown over the top of the pile to retain the heat, which more readily escapes. Where a consider-

New warehouse of Revillon Bros., Edmonton, Alta. Architect, Mr. J. McDiarmid, Winnipeg. Contractors, Messrs. J. McDiarmid Company, Limited, Winnipeg.

able amount of heating is provided for in advance, steam pipes are laid on the ground, and stone as received is dumped upon them. Then there is a canvas thrown over to prevent storms getting into the pile, and to retain heat. The frost is thus easily and economically removed.

Salt is frequently used in the water to lower its freezing point. It is seldom worth while to heat the water itself. Little care need be used to prevent mass concrete from freezing, as the frost will usually only strike to a depth of about one inch. Buildings are enclosed with tarpaulin tied onto an outside staging, and the enclosed space is heated with salamanders burning coke. Sometimes it is possible to use steam.

Frost is removed from form work by the use of salt and steam, and if the concrete surface is left rough it is common to sprinkle the top surface with salt to prevent freezing. In winter it is very common to put the finish on as a separate operation, after the building is inclosed, and not as an integral part of the construction, on account of the danger of freezing. When it is put on, it must be kept from freezing for the first forty-eight hours.

The expense of protection against the weather is not very great, and good results can be so surely guaranteed that it is not usual for the writer ever to discontinue work on account of cold weather.

Occasionally it is necessary to make some provision for the protection of the men. Shelters or windshields are built in front of the benches where carpenters are making up forms, as well as around the men at the concrete mixer, whose work does not necessarily keep them warm. Where excavation is going on in the open, it is expedient to have a building with a good fire where the men can warm themselves when necessary; and on a few jobs it has proved to be wise to furnish hot coffee free in these shelters.

It is estimated that during 1914 an expenditure of $60.000.000 will be made for road improvements in the Dominion. Of this amount more than $30 000 000 is available for expenditure from appropriations made by the legislatures of the various provinces.

Warehouse of Revillon Bros., Edmonton

ONE of the largest warehouses west of Winnipeg is that of Revillon Brothers, merchants trading into the North-West. Though simple in exterior design, and with no pretence at interior finish, the building, which was completed in Edmonton during the past year, attracts immediate attention by its bulk and simplicity. The superstructure is reinforced-concrete, the mushroom system being used, allowing of the maximum head room and unbroken illumination. The exterior is of sand-lime brick, about 700,000 of which were supplied by the Alsip Brick & Supply Company, Limited, of Edmonton. In plan the structure is 135 feet wide by 150 feet long, and is six storeys high above the basement. Columns are spaced 19 feet by 20 ft. 6 in. On the first floor are the local offices of the company, sample rooms and receiving and shipping rooms. Two freight elevators and one passenger elevator are installed, together with a spiral gravity conveyor. The building was designed by Mr. Jas. McDiarmid, of Winnipeg, and was erected by the J. McDiarmid Company, Limited, of Winnipeg, at a total cost of $250,000.

Water-Hammer in Steam Pipes

THE precise cause of water-hammer in steam pipes is not always fully understood. What, for example, is the approximate cause of the clicking in steam pipes? This is due either to the blows at pipe bends or valves of plugs of water in rapid movement or to collision of plugs of water upon water at rest, or to the collosion of plugs meeting from opposite directions. This is all easy to understand, but one does not visualize that these crackings over the length of a long piece of pipe arise from collisions of plugs travelling perhaps many feet, the rapid crackling simply indicating the rapidity of the movements involved. We have to discover how the water is put into such rapid movement. To do this the motive power must be discovered. This may be steam, or it may be, secondarily, air. Steam is approximately gaseous. Like all gaseous bodies it can be liquefied. But unlike the so-called permanent gases it will liquefy at such comparatively high temperatures as 212 deg. when at atmospheric pressures. According to the kinetic theory, a gas is merely an aggregation of extremely small molecules which are endowed by heat with the power of automobilism. Different gases possess different molecular velocities; for steam it is of the order of 1,800 ft. more or less per second, and the velocity of a mass of such molecules will depend upon the resistance against which they must make their way. In any cloud of steam surrounded by other gas at the same temperature the steam molecules are moving amongst each other, and those on the borders of the cloud are making their way slowly into the other surrounding gases. But if it be conceived that from one side of the cloud of steam all other gas be removed, then the steam molecules would have no molecules from which to rebound on that one side and would all rush down the empty lane.

This is what happens in a steam pipe: At some portion of the pipe there is water, cold relatively to the steam. Steam is admitted to the pipe and some of it condenses on the surface of the water, heating up the surface layer, which ceases to condense further steam. A valve is then opened in the course of the pipe; it is a valve against which, let us say, the water is lodging. The opening of the valve, allowing some water to pass, causes a disturbance of the surface, admits steam to the cold water, which promptly condenses so much steam as to produce a vacuum, into which steam rushes so violently that it piles up the water before it, and the wall of water is violently thrust forward by the steam and becomes a travelling plug of such energy that it is possible for great shocks to be set up which will readily burst or fracture cast-iron valves and other junction pieces.

The sequence of events above outlined is merely illustrative of what may happen, for the variations are as numerous as the ways of putting up steam pipes wrongly. One error formerly very common was to place a stop valve close to the boiler, taking off the steam by a vertical pipe to several feet high, when the pipe proceeded horizontally. This vertical pipe would be liable to become full of water if any steam could leak up into it from the boiler or condense into it from other boilers on the main. The correct position of the stop valve is at the top of the vertical pipe, and from it the main ought to slope all the way to engine separator. If there must be dips in between the terminals, they must be drained, and the drain must act. Expansion bends, unless they project horizontally from a steam pipe, will block the flow of water and provide water to form a flying plug.

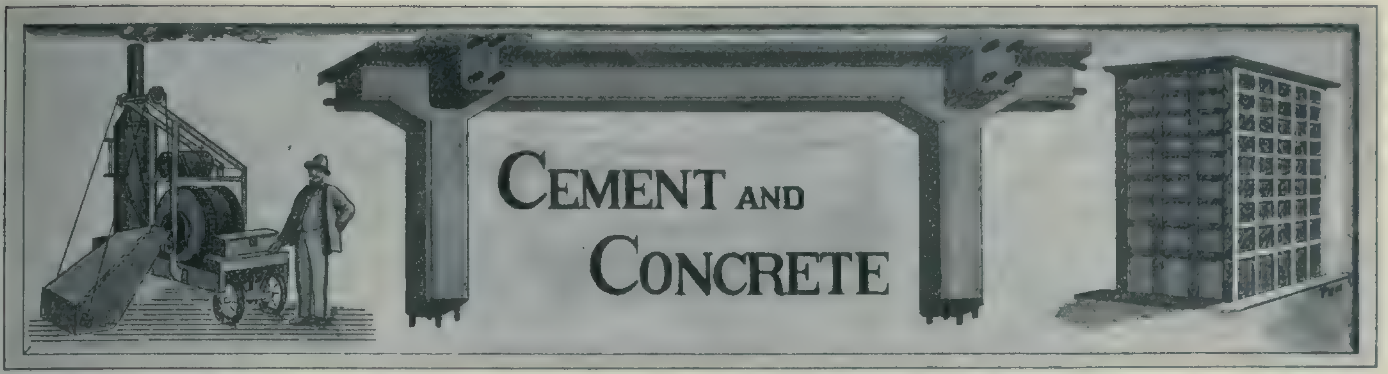
In designing any line of pipes or a system, all the possible combinations of opening, shut and leaking valves should be thought out to find if it is possible for water to collect. It is particularly desirable that the number of valves be a minimum. Numerous valves and ring mains are productive of danger points.

Where both air and water are present in a pipe it is possible for the air to be compressed at one end of the pipe, and for the compressing water to be flung back by the air into the steam end and do damage. Thus in a faulty arrangement the steam valve might first be opened slightly and promptly shut upon indication of trouble. And this very closing might produce a water-hammer by air rebound. Probably one of the more frequent hammer-causing faults is a slight slope of a pipe towards an obstruction with the formation of a long surface of water in a half-full pipe. This condition is one which might happen in a pipe which had been partially vacuous and nearly full of water. On admitting steam the traps would begin to lower the water, and produce the above conditions of a long surface to be broken into waves to set up rapid condensation.—Domestic Engineer.

Saskatchewan's New Provincial Gaol

REGINA is taking an important place in the constructional activity of the Dominion, judging from the many important enterprises which have been described in these columns during the last year or so. Particularly in building construction the capital city of Saskatchewan has established a claim to pre-eminence in the West. As the latest example of a number of important government buildings of recent date we reproduce a photograph of the new provincial gaol as it will appear upon completion. The contractors for this building are the Parsons Construction & Engineering Company, Limited, of Regina. The estimated cost of the administration block, chapel wing and south cell block—the portions of the building now under construction—is $275,000. The north cell block will be constructed at some future time when required. The building has reinforced concrete floor slabs with steel and brick cells. The chapel is covered with a steel roof and the whole facing of the building is of brick and stone.

Provincial Gaol, Regina, Sask. Architects: Messrs. Storey & Van Egmond; contractors: Messrs. Parsons Construction and Engineering Company, Limited.



Concrete in Factory Construction*

By Percival M. Fraser

It is now generally recognized that a well-equipped series of shops is an absolutely essential factor in a successful industrial concern. It is as important as the machinery and plant and the site. It is not difficult to prove that these will be crippled by being housed in unsuitable buildings, where the first must be limited in efficiency, under-driven, and wastefully or harmfully worked, and the second so badly utilized as to counteract its peculiar merits. To be completely efficient it is necessary to be as thoroughly up-to-date in the buildings as in the plant, for to be up-to-date means to have taken advantage of every development and improvement in machinery and organization, and, other things being equal, indirectly it is the most important factor in success.

The attempted adaptation of groups of buildings to a use foreign to that for which they were designed is one explanation of the grotesque jumble of nondescript buildings dignified by the name of industrial buildings which we so often see, and it is one of the reasons why this country is unable to maintain its ascendency in the world's manufacturing commerce.

It is also true that in the majority of cases economy could have been effected had the old buildings been scrapped and an entirely new series of buildings erected. I seriously suggest that the English factory owner requires educating in such matters as this, and that he has a great deal to learn from the United States on such points. The American will frankly admit that he does not build his factories for posterity, but is content if they last a couple of generations. I do not suggest that we are incapable in England of erecting efficient ranges of factories, and I trust that we shall never erect buildings which will depreciate 100 per cent. in fifty years, but there is a happy medium of design and expenditure in regard to factory construction which we should endeavor to seek.

There is a great deal that is incongruous in our industrial works. A typical English power plant represents the finest product of human workmanship, and the employees, from the chief engineer to the humblest stoker, take a pride in keeping it at its highest pitch of efficiency and scrupulously clean, for to their mechanical minds it is a thing of beauty; but this is ordinarily housed without scruple in a corrugated iron building, which is not only an eyesore but totally incapable of efficiently protecting the expensive machinery it contains. I have in mind an engineering works where some new machine tools, very complicated and costly and requiring perfect conditions of lighting, space, and drive, are housed in a corrugated iron and timber-framed building which was purchased and erected at a cost of £60, having previously been a gymnasium in connection with a boys' club. It is unfortunately this type of construction which reinforced concrete has to compete with in cost, though it is evident that such a building is dear at any price and possesses only one advantage—namely, that it is easily pulled down by the factory owner when he eventually finds that no adequate return on the capital outlay of the plant is possible under such conditions.

The Design of Industrial Buildings

Among the questions which frequently come before an architect in designing industrial buildings is the following:—Whether the building as a whole should be one storey or more in height. This question is often automatically disposed of by the cost of land, the amount of labor to be accommodated, and the nature of the machinery. Unless the foundations are likely to prove abnormally expensive it will generally be found, however, that the one-storey building can be constructed the more cheaply.

A second important detail which practically always arises is the question of eliminating columns or reducing their number and planning their position to the best effect. When the engineer does not object to columns be sure he has evil designs on them, and ample strength should be provided accordingly.

Other questions which must infallibly arise are the nature of the lighting, which must, for many manufacturers, be from the roof. In two-storey buildings the width of the building is determined hereby, but it is an advantage to make the upper floor with roof light. Too much daylight, unlike artificial light, cannot be provided, but the increase of window space will add to cost and complicate heating and ventilation. The north or sawtooth roof is always an advantage, but is not always worth the expense, costing, as it does, 10 per cent. more than an ordinary pitched roof in steel or 20 per cent. more than a flat roof in reinforced concrete.

With regard to the clear height of workrooms, a margin should be allowed over the bare necessity, as it is comparatively cheap to add to the height of a floor, and a lofty room conduces greatly to its general utility.

---

*Abstracted from a paper delivered at a meeting of the Concrete Institute (London).

Advantages and Disadvantages of Reinforced Concrete for Factory Construction in Comparison with the Prevailing Methods of Construction.

The serious competitors of reinforced concrete which are at present before the building world are as follows:—

Brick, steel, and cast-iron, wood, sheet-iron, and metal lathing and plastering, tiling, terra-cotta, or similar slabbing and casing, and a number of patent forms of construction too numerous to mention and most difficult to classify, most of which, however, come within the scope of reinforced concrete in one or more respects.

It is exceedingly difficult, if not impossible, to definitely pronounce on the comparative economies of the foregoing materials, and we can only take specific instances and endeavor to generalize from these. I am able to give a case where competitive prices were obtained for a building, which is of a fair size, straightforward, and a really useful one for this comparison. In this case alternative schemes were prepared in the fullest detail and competitive prices obtained. The results were as follows:—

	Per cent.
1. For a steel-frame building with brick walls, corrugated iron roof (two-thirds north light), wood joists and boards on steel bearers to galleries, and patent glazing to roofs, the cost was	100
2. For a reinforced concrete building with roofs as last.	92
3. As last, but with concrete roofs, part flat, part with north lantern lights, but with brick panel walls..	89
4. As No. 1, but with corrugated iron walls	89
5. Wholly in reinforced concrete	88

The building was actually carried out in reinforced concrete, including the gutters, down pipes, roofs, walls, foundations, and every detail where it was possible for this material to be used. I may say that in this case there were no special circumstances whatsoever in favor of reinforced concrete; indeed, the question of the supply of aggregate was a very difficult one, as it had to be brought from 25 to 30 miles by rail. In my experience I have found that the foregoing figures will apply to all classes of ordinary buildings costing more than, say, £2,000. A building of less cost will, generally speaking, be found cheaper in some other form of construction, and I believe walls will nearly always be found cheaper in brick panels than in concrete slabs.

Maintenance

The freedom of concrete from deterioration permits of savings in maintenance charges. These are exceedingly great in large series of factory buildings, and can never be shown on paper. Maintenance means more than merely guarding against the ravages of time. The necessity for maintenance implies decay; the maintenance costs are a dead loss, and maintenance is in itself a thankless job owing to the fact that it is simply patched-up work, merely staving off the inevitable, which every year becomes at once more onerous and more useless.

There is no material that I know of where maintenance is not necessary. Good brickwork is perhaps as free from this as any material provided the bricks are carefully selected, well built, and pointed in cement. In such a case brickwork should remain without repair indefinitely. This also applies to stonework where not exposed to smoke and fumes, but the use of stone is so restricted that it need not be further considered.

With regard to the use of steel-frame construction, I strongly believe that, as carried out at present, it is liable to serious depreciation, and it has the very great disadvantage in that this depreciation cannot be guarded against or amended. A very large number of buildings are erected where the steel construction is cased in brickwork with no special precautions taken to protect the steelwork permanently against rusting. The continental system of building up with steel construction and filling the panels with brickwork, leaving the construction of steelwork exposed and painting same, is, of course, liable to depreciation, which must invariably destroy the structure in the course of time.

The various forms of patent slabbings for walls and roofs depend entirely upon an applied outer surface, and no such construction is found to be really permanent. It is always liable to cracks, through which the moisture can penetrate and attack the body of the walls, and the failure of the casing rapidly follows.

Considering, therefore, the claims of reinforced concrete, without wishing to be unduly enthusiastic, I think it may be reasonably asserted that, after a lengthy trial and the closest scrutiny of our chemists, architects, engineers, and constructors, reinforced concrete is, practically speaking, free from depreciation if constructed according to the latest approved practice.

Fire-Resisting Properties

The fire-resisting properties of various forms of construction are of paramount importance in factory buildings. The effect of fire-resisting construction in reducing insurance premiums is but a small matter compared with the damage which ensues to a business owing to the extreme dislocation caused by a fire, which no insurance can ever cover, for we have to consider the financial loss in the shape of buildings, plant, and machinery ruined, the destruction of office documents which cannot be replaced, and the permanent loss of many skilled workmen who are thrown temporarily out of work, and the occasional terrible loss of life. The output of a firm is, moreover, temporarily paralyzed, the normal trend of business is disorganized for a considerable period, and the eventual effect is that the insurance company will not reinsure at the same rates.

Nothing is, of course, fireproof, but we have to seek for the nearest approach to this ideal. Ordinary reinforced concrete construction is as efficient a fire resister as can be found. The metal is naturally guarded against by the concrete covering. There is nothing combustible about the construction; it is not liable to exercise a dangerous thrusting or overturning action, even when heated and suddenly cooled. It is, of course, liable when quenched with a strong shower of cold water to have the covering of slabs and beams either flake off or disintegrate. It is rarely or never found that any of the concrete, beyond the covering to the reinforcement, suffers any irreparable damage. Any such covering can be broken away where loose and the building restored after the conflagration. It can therefore be fairly claimed that for factory construction, which requires a high standard for fire resistance, reinforced concrete can rival any other comparable method of construction.

A further consideration which applies mainly to warehouse buildings is the importance of affording the utmost floor space for the storage of goods. Construction in London is exceedingly onerous in this respect. Matters have been made considerably easier by the steel-frame amendment of the London Building Act, but it cannot be denied that a considerable encroachment on floor space can be avoided by the use of reinforced concrete walls and supports.

The objection to reinforced concrete, as compared with steel and cast-iron, in respect to posts and columns is that the floor space occupied is considerably more.

It should be remembered that if a steel stanchion is insulated against fire it would be practically as great in sectional area as a concrete column.

Adaptability

Perhaps the unique merit of reinforced concrete lies in its extraordinary adaptability. There is no other building material which can be put to such extraordinarily diverse uses without unwarrantable eccentricity or expense. The value of a material which can be used for practically any purpose which may arise in the construction of the wide variety of buildings comprised in industrial works need hardly be dilated upon. The practical economy of such a material is also evident. Provided there are no insurmountable difficulties in getting on to the site steel rods, timber, gravel, and cement, we have at hand constituents which are capable of being moulded into any shape and resisting any strain and fulfil purposes which collectively would require the use of a large number of different materials. In the ingredients of reinforced concrete there is nothing which cannot be readily obtained in the most remote locality of the kingdom. In my own experience, in places ten or more miles from the nearest station, concrete work always competed in point of economy with any other permanent form of construction, and wherever eccentric designs are to be carried out a plastic material will always hold its own with a material which has to be wrought into shape. And, indeed, it is difficult to conceive any form of building construction which it is not possible to carry out with reasonable economy in reinforced concrete.

Speed of Execution

Following on the adaptability of reinforced concrete is the speed with which construction can go forward. If a contractor will lay down a well-considered and efficient plant the rapidity with which a concrete job can go forward is remarkable. A larger number of workmen (mostly unskilled labor) can be usefully employed, and the building as a whole can be proceeded with uniformly and in a manner which simplifies supervision. Should it be found desirable in a steel or iron construction to make alteration, time is lost in waiting for the various revised members to be delivered. With reinforced concrete such deviations can readily be made.

Artistic Design

An objection which is often urged against concrete buildings, which does not apply to brickwork or the usual form of construction, is that it is by nature unsightly. If appearance is an object in a reinforced concrete building I do not hesitate for a moment to say that a very agreeable effect can be obtained by perfectly legitimate and economical means. Those interested in the possibilities of beauty in reinforced concrete will do well to read Professor Beresford Pite's paper published in the Transactions of this Institute, Vol. III.

Another objection which may be held against reinforced concrete, especially for factory construction, is the great difficulty of making alterations which may be found necessary for various reasons, such as an expansion of business. But, in the first place, a successful factory owner should be able to see so far ahead that possible extensions can be provided for at the outset; secondly, that the practice of installing departments into buildings not intended for their use always produces inefficiency and undue expense; and, thirdly, that, assuming the building has to be altered owing to circumstances which no brain could have foreseen, such extensions and alterations are not impossible. Even if the expense of same is abnormal it is one of those factors which every shrewd business man will be prepared for, for, in the same way, he has frequently to throw on the scrap-heap a valuable machine which has been supplanted by something which saves more time or labor in output.

It cannot be denied that concrete, when it has settled down, is an exceedingly tough material, but the great strength to which this material attains should hardly be urged as an objection to its use.

Fixing Plant

The one great advantage of structural steel in factory construction is the ease with which machinery can be fixed to the steel members. That this use is often turned into abuse is beside the point, but I have frequently heard engineers state that they prefer steel to reinforced concrete for this reason. A little foresight will enable an architect to meet this objection with satisfaction to the factory owner. If an engineer desires to fix, say, a light motor he does not hesitate to drill a steel stanchion or girder as may be necessary to get a good fixing. By drilling two holes 1 inch in diameter in a girder he reduces a section as indicated on the diagram, whereas similar fixing on a concrete beam in theory has no effect upon the strength of the beam. In this respect concrete is advantageous, and it is at least as cheap as drilling in steel.

The bulk of a concrete member is so comparatively large in relation to a rolled steel member of equivalent strength that the resulting damage of cutting into such member is proportionately reduced. Comparing the members shown, the sectional areas of the steel joist and of the concrete beam are in the proportion of 1 to 7 for equivalent strengths. It is obvious, therefore, that the concrete member will stand much more mutilation without jeopardising its strength than the steel joist. Provision should and can readily be made, therefore, for fixing to soffits of slabs or beams.

A simple means of providing for light fixings is obtained by casting a groove in the beams and columns, so that a fixing can be obtained with the greatest ease without in any way having to go into the concrete. For gas or water-pipes and mains or cables of any description this fixing is very simple, and a good engineering job; again, the indiscriminate fixing of shafting to walls is accompanied with greater safety on reinforced concrete slabs than on brickwork, which is liable to give along the joints, and the weight, of course, is not so evenly distributed.

The low thermal conductivity of concrete gives it an advantage over the ordinary forms of roofing, apart from other considerations. The usual precautions taken are to construct a roof of timber with thick boarding overlaid with felt, upon which are placed battens and counter-battens and thick slating. This forms a fairly effective insulation, but the construction is at least as expensive as a concrete flat asphalted. For flat roofs and in all places where exposed to damp or water pressure concrete can be made, with due care, absolutely waterproof, and a very valuable and convenient arrangement which is now often adopted is to construct concrete roofs with high parapet walls and utilize them for water storage. This has a further advantage that the water is generally at a convenient height to be drawn off under pressure.

A Practical Discussion of Reinforced Concrete Pavements

By B. S. Pease[*]

THE formation of cracks in concrete pavements is the conspicuous fault of a type of pavement low in first cost, offering slight resistance to traffic, while preserving a satisfactory traction, even on steep grades, and possessing a high sanitary value. Cracking may be induced by three factors—poor foundations, contraction during the setting period and natural expansion. The commonly used method of hindering cracking is by building the pavement in small units, with joints, but this is expensive and the joints are unsightly and not durable. Even when protected by steel plates, the line of cleavage is the weak portion of the wearing surface, and it is there that deterioration first occurs.

Steel reinforcement, though its use for pavement dates back only three or four years, appears capable of preventing the formation of cracks under all conditions when properly proportioned and placed. In 1913 at least fifty-six municipalities contained construction of this type, one and two-course pavements being about equally divided. The performance of these pavements indicates the ability of reinforcement to counteract the principal causes of cracking.

Theory of Pavement Reinforcement

Consider those pavements that will be laid on a questionable foundation. The necessity for reinforcement to give structural strength to the slab is evident, regardless of whether the foundation is poor in spots or over the entire area. If the foundation consists of filled material, it is almost impossible, even by the use of a heavy road roller, to prevent future settlement, and no one can tell at what points the settling will occur.

An excellent example of this class of work is shown by a pavement built on spongy land in Oakland, Cal. —a 6-in. slab reinforced near the bottom with a steel mesh, the type most commonly used. Upon especially soft spots a second thickness of the wire fabric was laid at right angles to the other. This roadway is giving good service under a heavy traffic.

In the construction of country roads a part of the metal will usually extend outside the old beaten track, and therefore the foundation will be more compact under the center portion. Even if the center be scarified and rerolled it will be almost impossible to secure a uniform result. This condition in itself will allow a settlement at the outer edges and cracks will form longitudinally unless suitable reinforcement be used near the top of the pavement. When a pavement contracts in setting or because of a reduction in temperature, cracks will form at more or less regular intervals, the distance between them depending largely upon the tensile strength of the concrete. It is for this reason that many engineers advocate a definite close spacing of expansion joints. At the same time they concede that these joints are the weak spots in the pavement; if some other method of construction could be used, therefore, so that the number of these joints could be reduced, its merits should be studied.

Position of Reinforcement

As concrete in itself has no dependable tensile strength, it is necessary to include a reinforcement to supply this deficiency. For several reasons the practice has been to place this reinforcement near the top of the slab. For a two-course pavement the logical position is between the base and wearing courses, where it will not only resist expansion and contraction of the entire slab but will also act as a connecting link between two bodies of concrete having a different mixture of the ingredients and will prevent the formation of cracks along the crown. For single-course work the reinforcement is usually placed about 2 in. below the surface. Although this type is called single course, it must of necessity be placed in the layers in order to include the reinforcement.

The amount of reinforcement to use, may vary with conditions, but the limited practice suggests that for country roads, if the expansion joints are placed not more than 30 ft. apart, sectional areas of .049 sq. in. per foot of width crosswise and .038 sq. in. lengthwise of the pavement will furnish sufficient resistance to prevent cracks due to shrinkage during setting, expansion or contraction from temperature changes, or any ordinary inequality of the foundation soil.

Spacing of Joints

The subject of proper spacing of expansion joints should be studied in connection with the consideration of the reinforcement, for the reason that the greater the spacing of joints the greater should be the amount of longitudinal steel.

Past experience points to the fact that the principal change in the length of a concrete pavement is a contraction, and the steel, although it has approximately the same coefficient of expansion as concrete, and will therefore change in length about the same amount, will prevent the shortening effect from being localized at definite intervals and will distribute the total change into innumerable small cracks that will not decrease the wearing qualities of the finished pavement. If the expansion joints are spaced at a greater distance than 30 ft. the amount of longitudinal steel should be increased to at least .1 sq. in. per foot width for spacing up to 100 ft., and the writer thoroughly believes that by the addition of a sufficient amount of longitudinal steel reinforcement it would be possible to construct a roadway without any expansion joints.

---

[*] Engineer for the American Steel & Wire Company, Chicago.

For street pavements the early practice was to use a very light reinforcement, but the more recent ones have made use of a heavier material, even for close spacing of expansion joints. In fact, the tendency now is to increase the weight of reinforcement, and since this item is small in comparison to the total cost of the finished work it would appear to be poor economy to use a light material when for a slight additional expense a proper construction can be assured. The average cost for the reinforcement in place ready for concreting varies from 7 to 15 cents per square yard, depending upon the weight of reinforcement used. The same recommendations and the reasons therefore that have been given for necessary reinforcement for country roads will also apply for city pavements, with the exception that, regardless of the weight of reinforcement used, expansion joints will be required at all street and alley intersections or wherever connected with any permanent rigid construction.

Method of Laying a Concrete Floor

TOO much care cannot be exercised in preparing the foundation for a concrete floor, comments a writer in The Building Age. This should always be well drained, and firmed to a depth of from 6 to 8 in. below the concrete. It pays to tamp this foundation thoroughly before putting on the mixture. If the soil contains a great deal of clay, it may be necessary to remove part of it and to fill in with broken stone, gravel or cinders to within 4 or 6 in. of the proposed finished surface, depending upon the thickness of the floor. Blind drains of coarse gravel or tile may be laid from the lowest points in the excavation to carry off any water that may accumulate beneath the structure.

For the construction of the ordinary stable or barn floor, which is not to carry any great weight, the following proportion is to be recommended for the concrete base, says H. M. Bainer, of the Colorado Agricultural College: One part cement, 2½ parts clean, sharp sand, and 5 parts loose gravel or broken stone. This should be finished on the surface with a 1 to 1½ in. layer of a mixture of 1 part cement and 1½ to 2 parts of clean, sharp sand. The total thickness of this floor must be from 5 to 8 in., depending upon the load it is to carry.

For engine foundations, floors, or driveways over which heavy loads pass, the following proportion is to be recommended: One part cement, 2 parts sand, and 4 parts broken stone or gravel.

Constructing Large Floors

For all large floors, it is advisable to place the concrete in sections not to exceed 6 ft. square. This may be done by placing a 2-in. plank of a width equal to the desired thickness of the floor on edge, as a box in which the concrete is tamped until water begins to show on top. Make several of these forms, holding the plank in place by means of stakes driven into the surface. These stakes should be driven on the outside of the form so that they can be easily removed after the concrete has partly set and the planks have been taken out. Fill alternate forms at first, tamping the concrete thoroughly, especially the edges. As soon as the concrete has partly set, remove the plank and fill in the forms not filled at first. Mark the side plank to show exactly where the joints come.

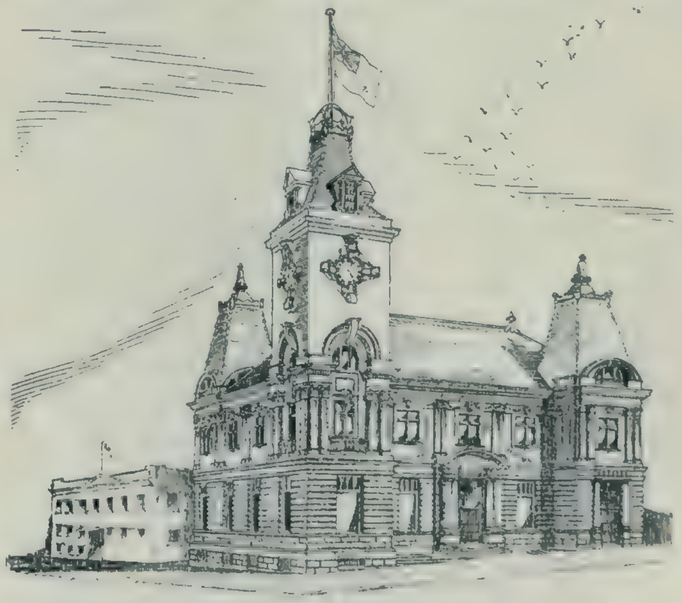
The finishing coat should be spread on before the concrete has set. To make this of uniform thickness it is best to place either 1-in. or ½-in. wood strips, as is desired, on top of the concrete, over which a straight edge may be run. Smooth with a trowel for a smooth surface, or with a wooden float for a rough surface. Groove exactly over the joints of the concrete so as to level the edges of each block. Do not trowel the surface too much, as it tends to separate the cement from the sand and injure the wearing surface.

The floor should be constructed with slope enough to carry all liquids to certain points from which they may be drained. Protect the new floor from the direct rays of the sun, currents of air, and frost; and keep constantly moistened for several days. Water is very important in the curing of concrete construction, and must be liberally used.

Use nothing but the best cement that can be obtained. The sand should be clean, sharp and not too fine; it should be freed from loam or clay, as these will tend to destroy the adhesive quality and retard the setting of the concrete. Use only pure water for mixing. Mix thoroughly. Water thoroughly. Cure thoroughly.

New Post Office, Mount Pleasant, B.C.

THE new sub-post office which the Dominion Department of Public Works proposes to establish in the Mount Pleasant district, Vancouver, during the present year, will be a substantial structure of dignified outward appearance, possessing admirable features of design and construction. Reinforced concrete will be employed for the construction of the building, and every precaution will be taken to render it absolutely fireproof. In addition to the exterior walls, the floors, beams and interior walls and columns will be of concrete and most of the windows will be fitted with wired glass and metal frames. The structure will measure 73 x 88 feet and will be erected on the corner of 15th avenue and Main street, a site, which on account of its commanding elevation provides an unobstructed outlook over the city. Ac-



Proposed post office, Mount Pleasant, B.C. Architect, Mr. A. Campbell Hope, Vancouver.

cording to the limited details available, the exterior facing of the basement storey will be rusticated stone and the succeeding storey will be faced with stone of finer grain and different tint in strongly-marked horizontal courses, finished above the ground floor windows with stone interpreture. This will be surmounted by a structure of faced brick having stone pilasters and window trim with suitable carved and ornamental work. The roof will be of a non-combustible material with copper trim. Hot water heating and a modern plumbing system will be installed. The ventilating is to be of the direct indirect type, with extraction fan in the clock tower. The building will be equipped with a two-pipe motor vacuum-cleaning system. The public space on the main floor will be fitted up in attractive style with a good class Canadian marble as a nine-foot wainscotting for the walls and columns. The ceiling and the balance of the walls in the post office proper will be of plaster, and interlocking rubber tile is to be used for the floor. A marble staircase will lead from this floor to the offices in the upper storey. The interior woodwork has not yet been decided upon, but it is believed that the Department will sanction the use of a finish of B. C. growth. Plans and specifications of this building have been completed, and it is expected that tenders for the construction will be called for during the coming spring. The estimated cost of the work is $100,000. Mr. A. Campbell Hope, Vancouver, prepared the plans.

An estimated annual waste of $750,000 in the construction of buildings in Toronto, as the result of unnecessary exactions by the building laws, is charged by Prof. C. R. Young, of the engineering department of the University of Toronto, in a report recently prepared by him. According to Professor Young steel construction costs from 3 to 8 per cent. and reinforced concrete 5 or 10 per cent. more than it would with reasonable and at the same time safe specifications.

At Leeds University, last month, Professor Goodman, lecturing on "Engineering Problems in the Pyramids," referred to the marvellous accuracy of the orientation of the Pyramid of Cheops, which faces almost exactly north, south, east, and west, and was probably used as an astronomical observatory. The granite and other stone blocks were worked with copper chisels, but how the chisels were hardened nobody could say. Sir Benjamin Baker and Sir John Aird, who built the Assouan Dam, agreed that Herodotus had made a reasonable estimate in stating that 100,000 men were employed three months a year for twenty years, and that 4,000 masons were constantly at work preparing the stone. Barracks had been discovered which would accommodate about 4,000 men.

Engineers' Club of Toronto—Annual Dinner

Evidences of keen enthusiasm in the constructive work that is being accomplished by the Engineers' Club of Toronto were provided in abundance at a representative gathering of the members at the annual dinner held on Thursday, March 12, at the headquarters, 94 King Street West, Toronto. The president, Col. Van Nostrand, occupied the chair and the speakers included Messrs. Willis Chipman, L. V. Rorke, Arthur Hewitt, C. H. Heys and W. A. Bucke. The gratifying announcement is made that the directors have secured a site on University Avenue for the erection of a new Club building. Enterprising measures looking to the erection of an up-to-date building will be taken at once. The speeches were enlivened by the interspersion of song and story.

The Principles of Efficiency Engineering Applied to Highway Engineering

By Frank B. Gilbreth, Consulting Engineer, New York City*

IT is a fortunate thing for engineers that from its very start Scientific Management was understood to apply to the work of the engineer. It has been the custom for some years to ascertain the science of management especially with shop work and to believe that its principles are most successfully applied in manufacturing, but, as the breadth of the field of application of the principles of Scientific Management has become better understood, it has been realized that there is no field of activity to which the principles do not apply and that there is no type of work, office work, shop work, field work, manufacturing, constructing, selling, advertising, etc., which cannot be done better, if the theory of Scientific Management be understood and the practice of Scientific Management be applied.

Principles Defined

The principles of Scientific Management have been defined by Mr. Taylor as four:

1. A development of a science for each element of a man's work, which replaces the old rule of thumb method.
2. Scientific selection and training of the workmen.
3. Hearty co-operation between management and men.
4. An almost equal division of the work and the responsibility between the management and the workmen.

This order is that of the development of the science of management. For purposes of installation we might change the order a little, and say that we are to do four things:

1. To functionalize the work so that each member of the organization does that part of the work that he is best fitted to do.
2. To inculcate that spirit of co-operation that will make each member willing to do the work that is assigned to him.
3. To standardize.
4. To teach each member of the organization so that he can best perform his part of the work.

Having thoroughly laid out the problem on the human side and on the material side, and laid out a method of attack to the desired result, it is necessary, before actually making any changes, to insure the hearty co-operation of every member of the organization. This is done by various methods.

1. By an educational campaign, by explaining so far as is desirable and desired the entire plan of Scientific Management and the plan of application to the line of work attempted.
2. By beginning the actual work so far as is possible on the management side. This for two reasons.
    (1) The management side in the majority of cases needs the work most.
    (2) The men will be much more willing to have the system applied to them, if they see it being applied to the management.

Co-operation, once secured, can be held by seeing that every step is made in the open and by seeing that every man receives a suitable, prompt, assured reward for everything that he does.

Concerning Standardization

Having laid out your plant and secured the co-operation of your men, it is necessary to standardize. Standardization consists of two parts:

---

* 'Lecture delivered by Professor J. Ansel Brooks, of Brown University, before the Graduate Students in Highway Engineering at Columbia University, March 2, 1914.

1. Securing a standard.
2. Applying the standard.

I will consider the application of the standards first as the subject is less technical, and as so many standards have been already established that you will be able to apply the result of the work of others in many cases before finding it necessary to take the actual measurements and find the actual standards for yourself. Devices, while they must in no way be confounded with the science of management, are excellent in applying the principles of standardization. According to the rule just given—that work should be done on the management side first—I will show yo a few office standards which may be easily established and which will help the management and office force to visualize the problem of standardization. In themselves these devices are nothing; as showing the importance of the principle of standardization they mean a great deal. The cross-sectioned desk with its standardized equipment, and the arrangement of the various drawers for the various types of work will not only interest everyone about the plant, but will so substantially cut down the work of all using them as to insure sympathy with as well as interest in the work. More than this, in our personal experience they have inculcated a spirit of "thinking in least motions," a better method of attack, which has proved a most valuable asset. This same spirit has been the result of the installation of standard devices in the shop. I will show you the bulletin board, which applies both to the planning and the performing department, the tool room, the tool stand and the assembling packet. The bulletin board is universal in its field of application. There is no one in the organization whose work may not be handled on the bulletin board. It thus serves as a unifying point as well as a standard method of handling work. The tool room, while actually operated by but a few men, affects the work of the entire performing department and is an admirable object lesson as to the benefits of standardization. The assembly packet, while invented to cut down the motions of the assembler of a braider, illustrates a principle of so placing material that it can be handled with the greatest care that is, as you can readily see, applicable to every type of work.

We will turn next to the derivation of these standards. They are the result of that accurate measurement that gives management its claim to be a true science. The methods of measurement, as you know, are time study and motion study. Time study, upon which the science of measurement hangs, is a determination of the elementary unit times necessary to perform an operation. Motion study is the determination of the proper elements to be timed. The two are parts of one whole, i.e, accurate measurement.

Last, but not least in importance, we come to the training or teaching of the men. This is done, directly, through instruction cards and through the functional foremen, who are all specialist teachers; and, indirectly, through the installation of Scientific Management itself. Everyone in the entire organization, management and men alike, if the installation have been properly done, becomes interested in the science of management and in the method of attack which it employs. This interest is the greatest educative force in Scientific Management. If you develop this interest in the subject, the application of the principles of the science of management to your specialty is bound to result not only in success to you individually but to the profession to which you devote your lives.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

A supplementary vote of $100,000 is to be made to Leamington for the building of a breakwater outside the harbor in Lake Erie.

Montreal building work upon which tenders closed last week included a college building estimated to cost $400,000 for Layola College.

Mr. M. H. Braden is the contractor for the three-storey customs house building to be erected at Fort William, Ont., at a cost of $175,000.

The new R. C. church at Chicoutimi, Que., erected at a cost of $325,000, according to the plans of Mr. R. P. Lemay, Quebec, is nearing completion.

The National Amateur Athletic Association of Montreal, Que., have plans in hand for a new club-house estimated to cost a quarter of a million dollars.

If the plans of Montreal Agencies, Limited, materialize, another apartment house will be erected in Montreal this season at a cost of $1,000,000.

The steel work of the new post-office at St. John, N.B., is completed. The estimated cost of the building is $500,000. Mr. G. E. Fairweather, of St. John, is the architect.

The million-dollar carbide plant at Welland, Ont., which is being erected for the Union Carbide Company by the Lackawana Bridge Company, Buffalo, N.Y., is nearing completion.

Sydney, N.B., is to have a $125,000 technical school for which preliminary plans have been prepared by Professor F. H. Sexton, acting on the instructions of the Board of Education.

The Algoma Steel Corporation, Limited, Sault Ste. Marie, will receive tenders about May 1 for open hearth furnaces at Steelton, Ont. The cost of the work is placed at $250,000.

The Starrett Company, Detroit, Mich., have the contract for the new factory buildings of the Canadian Alkali Company, Limited, to be erected at Sandwich, Ont., at a cost of $2,000,000.

Montreal contractors will be asked to tender next month on an apartment house for which Messrs. Gauthier & Daoust, architects, have prepared the plans. The cost is placed at $200,000.

Mr. A. E. Anderson, Montreal, is the architect for two stores and a theatre to be erected at St. John, N.B., at a cost of $120,000. Tenders for the work have been submitted and are now under consideration.

The parish of St. Eusebe de Verceil, Montreal, is contemplating the erection of a church at a cost of $150,000.

The architects, Messrs. Beaugrand, Champagne & Chenevert, will call for tenders about May 1.

Excavation work has been commenced on St. Paul's new club house on the north side of Queen Street East, Toronto. The structure will cost between $40,000 and $50,000.

Building permits issued in Hamilton for the month of February amounted to $163,100 as against $152,500 for the corresponding period of last year. The increase for February is $42,000 over that of the same month in 1912.

From the report of the Minister of Public Works we learn that the expenditure on permanent bridges in New Brunswick during the year was $525,123. On railway roads and bridges the outlay totalled $319,565. The expenditure on roads was $272,500.

During the year 1913, 260,000 tons of gypsum were shipped from Windsor, N.S., to New York. This year it is expected the output will be increased considerably, and everything points to the fact that the industry is growing rapidly in that part of the Maritime Provinces.

According to a recent report approximately sixty million dollars is available for the improvement of the roads of the Dominion of Canada during the present year. Of this sum more than half is available for expenditure from appropriations made by the legislature to the various provinces.

The hydro-electric radial field day convention passed resolutions at London, Ont., on March 5, calling upon the Dominion Government to assist the hydro railway scheme to the extent of $6,400 a mile, and requesting that the plans for furthering the deep waterways projects be favorably acted upon.

The emptying of the Lachine Canal which took place this year a month earlier than usual, to allow work on a power plant at Cote St. Paul's to be carried on by the government, is said to have resulted in serious inconvenience to several manufacturers whose plants are located on the banks of the canal.

Mr. B. C. Munnings is contractor for the new revolving flash light which the Dominion Government has decided to place in Goderich harbor. The old light-house which was erected over eighty years ago is being partially demolished to accommodate the new structure. Mr. K. G. Eagan, of Ottawa, is in charge of the work.

The inland marine interests in Montreal are considering the desirability of constructing a new drydock in the canal basin, claiming that the present drydock is not large enough to accommodate the present boat traffic on the canals. The project is at present in the hands of the harbor and navigation committee of the Board of Trade.

A law suit has been begun in the Brooklyn supreme court by Mr. Walter G. A. Hemming against Mr. James B. Craven, an engineer, for half interest in the contract given by the Canadian Government to Mr. Craven, to improve St. John harbor. The contract, which involves about $3,000,000, was subsequently assigned to the Norton-Griffiths Company of England.

Mr. Harris, city commissioner of Toronto, has supplied plans for renewing the bridges on Strachan Avenue over the C. P. R. and G. T. R. tracks, and raising the elevation of the roadway sufficiently to give a standard Dominion clearance of 22 ft. 6 in. over the base rails. The estimated cost of the work is placed at $114,300, and debentures have been authorized for $58,200.

A deputation from New Ontario waited upon the Dominion Government recently to urge the taking of steps to develop the deposits that are scattered through the Lake Superior country, and also to assist the iron industry in that part of Canada. The deputation, which was headed by the mayor of Sault Ste. Marie, represented the associated boards of trade of northern Ontario.

Over thirty architects from Toronto, New York, Ottawa, Montreal, Sherbrooke, Three Rivers and Quebec, are likely to submit competitive plans for the new fireproof-concrete grand stand which the Quebec Exhibition Commission are about to erect at an estimated cost of about $100,000.

Engineering and building interests were strongly represented at the annual dinner of the Technology Club of Lower Canada held in Montreal. Among the toasts were "Building Construction along the C. P. R.," responded to by T. E. Videtto; "Electrical Engineering in Canada," W. J. O'Leary; "Transportation Problems in Canada," Prof. Keay; "Tunnel Work in Canada," S. P. Brown; "Pleasures of Municipal Engineering," G. R. Heckle; and "Montreal Architecture," G. T. Hyde.

Mr. Beckwith, assistant government engineer, was in North Sydney, N.S., recently, consulting with the resident engineer regarding the location of the proposed new bridge line of the Intercolonial Railway from that town to Leitches Creek. New deep water terminals are also to be built at Sydney and in connection with both projects surveys are being made with a view to preparing estimates of cost of construction. Reports and recommendations will be laid before the next session of Parliament.

In connection with the Montreal conduit break controversy a special meeting of the enquiry, under the presidency of the mayor, was held on March 4 to hear the views of Mr. Rodger Miller, of Ingersoll, Ont. Mr. Miller, who is a concrete expert who has had long experience in the use of concrete in canal construction from Sault Ste. Marie to the Soulanges canal, bore out the contentions of chief engineer Janin that the break was due not to the inherent weaknesses of the structure, but to the working of the drag-line excavator nearby.

The Maritime Dredging Company have begun work levelling off some of the cribs already sunk in preparation for the concrete walls which will be built by the E. G. N. Cape Company, for the new Carleton wharf at St. John, N.B. A cargo of about one million feet of hard pine is being shipped to St. John from the southern states, the intention being to use this pine until the arrival from the woods of the New Brunswick timber which has been contracted for during the present winter. There has already been built and laid 1,523 feet of crib work, and the remainder in order to fill the contract for this year amounts to 2,390 feet.

Two new berths will be available at West St. John for the next winter season, according to plans now under way for better accommodation. One of the berths, which will be 860 feet long, will be equipped with a modern steel warehouse. Preliminary work prior to the construction of the new wharves at Sand Point is now under way and the C. G. M. Cape Company will carry the materials for the concrete to the mixers by means of a train of small cars drawn by construction locomotives, the mixers to be run continuously. The larger wharf will be 850 feet long, the other will have a length of 600 feet extending on a line with the old Canadian Pacific Railway pier.

A feature of the proposed improvements by the city of Westmount, P.Q., is the new lighting scheme and the construction of conduits. Recently the city installed a number of magnetite arc lamps in a portion of the city, a conduit being constructed to carry the wires and also those of the police and fire departments, besides those of the power companies. It is now proposed to extend this conduit system on all the main thoroughfares and to provide standard lighting. Conduits will be laid in the boulevards and lanes, and the unsightly poles abolished. It is also proposed to build a new city hall, at a cost of $271,000, of which the building will absorb $184,000. Besides paving lanes, opening up new streets and extending thoroughfares, the council desire to do a large amount of general road work, and to purchase additional plant, including motor trucks and flushers.

Negotiations for an adjustment of wages are proceeding between the Montreal Builders' Exchange and the Building Trades Council. Recently the various trades united in a federation, and they now have made demands for a higher scale and for a reduction in hours. The following is the present scale and the increases asked for:—Structural ironworkers, 35 to 45 cents an hour; tilers, 45 to 55c.; plumbers, 40 to 42½; steamfitters, 35 to 42½; plumbers' help, 15 to 25; marble cutters, 40 to 45; marble setters, 40 to 45; painters, 35 to 40; tinsmiths and roofers, 30 to 40; cement finishers (foremen), 40 to 45. At present only three sections of the Building Trade have agreements with the Builders' Exchange, and others are now asking for these—at, of course, the higher scale. It is also suggested that an arbitration board should be formed, with the object of avoiding strikes and lock-outs. The masters are not inclined to accede to the full requests of the men, especially as they believe that the building programme this year will not be very extensive. The cost of building in Montreal is already very high, and to increase the wages as demanded is calculated to discourage operations, particularly as regards important structures.

WESTERN CANADA

Operations are starting on the new Grand Trunk Pacific depot at Calgary, estimated to cost $300,000.

Construction work on the $1,500,000 Government Elevators at Moose Jaw, which has been held up during the cold weather, will be resumed as soon as the weather permits.

Good progress is reported on the preparation of plans for the new seventeen-roomed school at Edmonton, Alta., to be built by the Public School Board at a cost of $150,000.

Messrs. Carter, Halls & Aldinger Company, of Winnipeg, have the contract for the completion of the hotel building for the Olympia Cafe Company. The estimated cost is $400,000.

Medicine Hat, Alta., is to have a new 6-storey business block. The structure will be of reinforced concrete and will cost $225,000. Mr. A. Dickinson, a local architect, has the plans in hand.

Under the direction of the Secretary of the Department of Public Works (Mr. R. C. Desrochers, Ottawa), plans are being prepared for a customs house to be erected at Regina, Sask., at a cost of $200,000.

A report to hand states that shipments to the Consolidated Company's smelter at Thail, B.C., for the week ending February 28, totalled 8,207 tons, which is nearly 1,000 tons above the average for the first eight weeks of 1914.

The new school building at Oak's Bay, B.C., which was opened recently involved an outlay of $80,000, to which the Provincial Government has contributed $40,000. The building was designed by Mr. C. E. Watkins and built by Luney Bros.

Permission is to be given by the City of Victoria, B.C., to the Hudson Bay Company to instal below the surface of the roadway storage tanks for fuel oil to be used for heating purposes in the new stores to be built by the company on Douglas street, Victoria.

Saskatoon's constructional programme for 1914, as already outlined, involves an expenditure of between four and five millions. The municipal engineering department will spend $554,850, while the larger buildings already planned involve an outlay of over four million dollars. It is fair to assume that Saskatoon will benefit considerably from the increased activity which will be experienced in the district between Saskatoon and Calgary upon the operation of the new C. N. R. line between these cities.

The Lang Cove site for a government drydock at Esquimalt will be immediately purchased following an order-in-council passed at Ottawa. The dock is to be eleven hundred feet long and the preparation of plans and specifications is to be proceeded with right away.

At a cost of about $130,000, the Parsons Construction Company have completed a new Winter Fair building at Regina. It is 320 feet long by 200 feet wide and is of brick and steel construction. The judging amphitheatre is 220 feet by 85 feet, and seating capacity is provided for 5,500 people. A steam heating plant has been installed at a cost of about $20,000.

Dr. G. A. Ings, who is promoting a big power project up the Elbow River in connection with coal and iron schemes in Alberta, has suggested that if the City of Calgary proceed with the scheme of bringing a new water supply from the mountains they should enter into a joint water power and supply scheme. The proposal is to erect a big power dam which will save the city the cost of building a storage dam. The water supply will be taken from the tail race of the power dam.

The Burrard Peninsula Joint Sewers Commission plans the expenditure of over $2,000,000 in Greater Vancouver during the present year, according to a statement by Mr. Frank Bowser, chairman of the commission. Of this total the approximate outlays will be $1,000,000 in Vancouver, $750,000 in South Vancouver, $100,000 in Point Grey, and $100,000 in Burnaby. The intention of the board is to do the early work along the lines of density of population where improvements are necessarily imperative. Extension work is also contemplated in connection with the Balaclava trunk sewer.

An event which exemplifies the phenomenal growth of Calgary is the construction of the Hotel Paliser, for the Canadian Pacific Railway in that city. The hotel was started in the winter of 1911-12, and will be ready for opening in May. Externally the building is French Rennaisance. Buff pressed brick, Roman size, is used for the facing of the walls, while the trimmings are of Indiana limestone. Its ground measurements are 227 feet by 145 feet, rising to a height of 120 feet above the sidewalk. It comprises ten floors—basement, ground, mezzanine and seven service floors, with a garden and sun parlor on the roof. The structure is of steel and reinforced-concrete throughout. Altogether there will be 315 bedrooms and 278 bathrooms. A feature of the building is the installation of a maids' signal system between the office and other parts of the hotel. The heating in use throughout is the direct-steam system, the principal rooms being under a system of temperature regulation. The architects are Messrs. E. & W. S. Maxwell, and the contractors F. Lyall & Sons Construction Company.

Mr. J. A. Weller, C.E., engineer-in-charge of the new Welland canal, recently gave an interesting address before the Ottawa branch of the Canadian Civil Engineers at Ottawa, on the subject of the engineering difficulties that have been overcome in connection with the construction of the Welland canal. He announced that it was expected that all contracts would be completed in time to allow for the opening of the canal in 1918.

Mr. J. H. Larmonth, general manager of the Electric Power Company, Limited, Toronto, has been selected as the new superintendent of the Edmonton Street Railway, to succeed Mr. W. T. Woodroff, resigned.

Personal Mention

Mr. J. W. Lyon was elected president of the Guelph Radial Railway Company at the annual general meeting held on March 10.

Mr. E. W. Cox has been elected to the board of directors of Canada Cement Company in the place of his father, the late Senator Cox.

Messrs. Langley & Howland, architects, are now occupying new offices in the North American Life Building, 112 to 118 King Street West, Toronto.

Mr. Alfred M. Wright, the Montreal manager of E. T. Giberson & Company, Limited, Bedford Indiana limestone, has been elected vice-president of the company.

Messrs. Ross & Macdonald, architects, Montreal, Toronto and Winnipeg, have removed their Winnipeg office from 928 Union Bank Building to 508 Tribune Building.

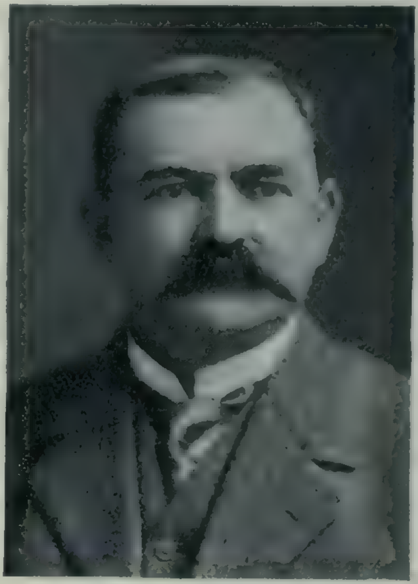
Mr. G. Sylvester, of Calgary, has been elected president of the Alberta Provincial Builders' Exchange for the ensuing year, and Mr. H. J. Goode, Lethbridge, vice-president.

Mr. Vincent Simpson, of Gerald Lomer, Limited, Montreal, Canadian sales agents for the Phoenix Steel Works, Dusseldorf, Germany, is now in the West on a business trip. He will visit Edmonton, Vancouver, and other cities in the Western provinces.

Mr. John Hastie, to whom we have pleasure in introducing our readers, is President of the British Columbia Construction & Engineering Company, general contractors, Victoria, B.C. As announced in the Contracts Department of our issue of February 25, Mr. Hastie's firm was recently awarded the contract for the departmental store to be erected at Victoria by the Hudson's Bay Company. Under the direction of Mr. Hastie many important operations have been carried out by the company. The buildings erected during the last two years include the Union Club Building, the Central Building, the Jones Building and the British Columbia Permanent Loan Building, aggregating an expenditure of one million dollars. The firm now have under construction the provincial gaol for the British Columbia government and the new Pantages theatre, the former being estimated to cost $250,000 and the latter $150,000. Mr. Hastie is a native of Huron County, Ontario. He went wes a quarter of a century ago and has been engaged continuously in contracting and building operations.

Mr. John Hastie, Vancouver.

Mr. John Laing Weller, Chief Engineer of the Welland Canal—the progress, design and construction of which were the subject of an article in our last issue—was born at Cobourg, Ont., fifty-two years ago. Graduating from the Royal Military College, Kingston, he was appointed Assistant Engineer on the Trent Canal in 1883 and on the Murray Canal in 1885. From 1888 to 1900 he was Principal Assistant Engineer on the St. Lawrence Canals and from 1900 to 1912 Superintending Engineer on the Welland Canal. In the latter year he was appointed to his present post of Engineer-in-Charge of the Survey, Design and Construction of the Welland Ship Canal. Mr. Weller's professional experiences have been of a responsible and varied character. At the time of the disastrous break in the Cornwall Canal Bank, in 1908, it was he who was placed in charge of the repairs. That he has not specialized in canal work to the exclusion of everything else is evidenced by the fact that he was the original inventor of reinforced concrete poles for electric lines. Apart from that he has had a distinguished military career. In the Northwest Rebellion of 1885 he served as a lieutenant in the Midland Battalion and became Staff Adjutant at the Base under Major-General J. W. Laurie. Later he was promoted Captain and Adjutant of the 59th Stormont and Glengarry Regiment. He retired when Senior Major. In 1885 he married Madelein M., daughter of J. J. Whitehead, Kingston, Ont. He has a family of one son and two daughters.



Mr. J. L. Weller, M. Can. Soc. C.E., Chief Engineer Welland Canal System.

Sir Thomas Tait, whose name is mentioned in connection with the High Commissionership of Canada, is well known in railway circles in the Dominion. He was a prominent figure as one of the Victoria railway commissioners in Australia some years ago.

Mr. Frank Ditchfield, formerly general superintendent of the Canadian Car and Foundry Company, Limited, has been appointed to the staff of the Mechanical Engineering Company, Limited, of Montreal. He will direct the affairs of the company's consulting engineering department.

Dr. Parks, of the University of Toronto, lectured on "Canadian Marbles" before the Canadian Institute of Civil Engineers on March 8. He was convinced that the future of the marble industry in Ontario would be determined by the extent to which colored marbles were quarried.

Canadian Railroad Development

A contract is reported to have been let for commencing the construction of the Duluth to Fort William and Port Arthur railway.

An application by the Canadian Pacific Railway to construct a large tunnel in Glacier Park, near Rogers Pass, B.C., has been granted by the Dominion Government. The tunnel will be bored through the Beaver Mouth and Rose Creek, a distance of about fourteen miles.

The Hydro-electric Radial field-day convention passed resolutions at London, Ont., on March 5 calling upon the Dominion Government to assist the hydro railway scheme to the extent of $6,400 a mile, and requesting that the plans for furthering the deep waterways projects be favorably acted upon.

The members of the Canadian Mining Institute while holding their sixteenth annual meeting at Montreal recently were conducted through the Mount Royal tunnel by Mr. S. P. Brown, chief engineer of the Canadian Northern Railway, and Dr. J. Austen Bancroft, Professor of Geology at McGill University.

According to a statement made by the Premier of British Columbia the Peace River line of railway as far as Parsnip River might eventually become the first section of the line through Northern British Columbia, the Yukon and Alaska. The average cost of the Pacific Great Eastern Railway is said to be over $58,000 per mile, which brings the total cost to about $27,840,000.

Mr. T. E. Wilkie, engineer-in-charge of the work, states that both of the Toronto Suburban Railway's extensions to Guelph and Woodbridge will be in operation this summer. On the line to Guelph about 98 p.c. of the grading has been completed between that city and the present terminus at Lambton Mills. Of the 46 miles of track on this road yet to be laid only about 1½ miles of grading remain to be completed in the neighborhood of Cooksville.

A culvert under a 170-ft. fill was recently completed on the Columbia Western Railroad about 30 miles west of Robson, B.C., where a high trestle on the Cascade Tunnel grade has been filled in. The crossing is in a narrow canyon, and it was considered cheapest to sluice the fill material from the adjacent hills by the use of hydraulic giants. The culvert, which is about 500 ft. long, was built up of masonry and has an arched roof with a span of about 12 ft.

Messrs. Dartnell, Limited, announce that Mr. W. H. Evans, C.E., has joined their sales staff. Mr. Evans comes direct from Toch Bros., New York City, where he has had a number of years experience in selling technical paints and waterproofing materials. Besides having a thorough knowledge of technical points, Mr. Evans is a practical waterproofing engineer. The Dartnell people look for a great increase in their R. I. W. and Toxement business following this appointment.

Sir Richard McBride, Premier of British Columbia, in a speech before the legislature recently, expressed the view that the time had now come for building a railroad through northern British Columbia to the Yukon and Alaska, the authorities at Washington and Ottawa having gone so far as to endorse some project of co-operation in the construction of this line. The Premier said that the project was too expensive for the province to take up single-handed, but that it lay within the power of Washington and Ottawa to approach and secure its completion within the next five years.

The Toronto Terminals Railway Company had its organization meeting recently, at which directors were elected. The new company has a capital of $2,000,000, the Grand Trunk and Canadian Pacific railways each owning a half interest. It is understood that revised plans for the Union Depot are almost completed and will be presented to the railway commission for ratification immediately. Contracts for the station will then be let and work on the $15,000,000 project of station and viaduct will proceed.

Of the larger contracts pending, a prominent place must be given to the construction on the western irrigation work of the Canadian Pacific Railway, for which tenders are now being called by Mr. A. S. Dawson, Chief Engineer, Calgary, Alta. The work includes the timber structures in about half the area of the eastern section of the company's irrigation block in Alberta. The approximate quantities given are, 3,550,000 ft. B.M. of timber and 18,000 cu. yds. of excavation. All materials are to be furnished by the railway company.

The firm of Norton, Callard & Company, with offices at No. 4 Hospital Street, Montreal, were registered recently. For seventeen years, Mr. Norton was private secretary to Mr. Charles R. Hosmer, and Mr. Callard was with Messrs. James W. Pyke & Company for eleven years and Purchasing Agent with Canadian Allis-Chalmers, Limited, for three years. They represent Joseph Cookson, Limited, of Manchester, England, manufacturers of cotton waste, wipers, ropes, twines and flags, and J. H. Gautier & Company, of Jersey City, manufacturers of crucibles and gas retorts.

The new viaduct for the Canadian Northern Railway spanning the Black Canyon on the Thompson river a few miles below Ascroft, B.C., is reported to be nearing completion. From an engineering standpoint this bridge was one of the most difficult pieces of work in connection with the British Columbia mainland right-of-way. The structure had to be erected without the aid of false work and the fact that the line enters a 1,300-foot tunnel made the problem somewhat difficult to solve. An abutment was built on the tunnel's side and the massive steel girders were placed in position by means of a huge derrick which swung over the gorge. The main span is 210 feet long, and the total length 245 feet. The bridge is built of truss girders.

The Canadian Society of Civil Engineers have memorialized the Federal Government to appoint a commission to consist of a railway engineer, hydraulic engineer, railway manager, lawyer, transportation manager, two business men (one from the east and the other from the west), and a secretary, with the object of making recommendations on the general subject of improving rivers, lakes and waterways. With regard to railways the enquiry would be directed to defining what is the reasonable relation between earnings and expenses, to improve the Atlantic, Pacific and interior terminals, and also the Hudson Bay route. The memorial is prompted by the view that the early completion of the Panama Canal and the great developments of all lines of industry will raise questions calling for more than ordinary methods of solution.

The reports of the experts who have been engaged by the Government to report on the possibility of the construction of a bridge across the St. John river below Gage Town, for the St. John Valley Railway, have been tabled in the New Brunswick legislature by Premier Flemming. The experts were Mr. C. H. Monsarat, chief engineer of the Quebec Bridge board, and the Foundation Company, Limited, of Montreal. Both agreed that it was a practical proposition to build a bridge across the river at what is known as Dunham's Wharf site, which was one of three suggested. The cost of the entire structure, with equipment, is estimated by Mr. Monsarat at $2,063,756, while that of the Foundation Company, who undertook to build the substructure, was $1,395,000. The latter estimate however did not specify for ice breakers on each of the small piers which it is proposed to have placed 80 feet apart; these if placed would cost about $90,000, the difference in the two estimates.

A Special Blast Hole Cable Drill

WITH the growth of the rock-crushing business both as a commercial proposition and in conjunction with the industries, the use of the steam shovel became introduced more widely and the economy of big-hole blasting became a practical proposition. This feature of quarrying was introduced first in an experimental way in some of the largest crusher quarries and has rapidly grown to be an indispensable practice with those who find the need of moving rock at the minimum cost. The big-hole blast is more efficient in parallel lines with the size or dimensions of the operations, and bounded by the desired capacity of the crusher output.

To take care of the requirements of the particular features of big-hole drilling in crushed rock quarries there were adaptations necessary to be introduced to perfect the known types of drilling machines already in existence at the time of the beginning of the interest in the matter, and now with practical perfection in the machine itself to do the drilling, big-hole blasting is an indispensable feature in every quarry of large production. First, it economizes the cost of drilling in the total amount of the year's appropriations for such purposes; it economizes in dynamite, for the reason that with a deeper hole and the larger volume of explosive the last bit of its efficiency is brought into use and none of it is exploded idly in the air above the blast hole, as is the case in shallow and small holes.

It is more economical for the reason that the amount of rock moved from the quarry face will give the steam shovels a longer period of work in one "set," and again the blast can be made more efficient because it becomes an important part of the operations worthy of the attention of the superintendent to so place his holes as to give well calculated results, so that known results from a given amount of dynamite can be put into every calculation.

The cable drill system of drilling was first introduced into quarries for the purpose of drilling blast holes in or around the year 1902, and while it was not accepted generally at that time, the larger operators are now beginning to appreciate the advantages offered in this system of drilling; and we might say that ninety per cent. of the cable drills used in blast hole work up to the present date have been purchased within the last three to four years' time.

Water well drills of the cable type have heretofore been used almost exclusively for this purpose and the Armstrong Manufacturing Company, Waterloo, Ia., working on the theory that the action of the tools that would generate the highest efficiency in a water well drill designed for drilling through soft materials and in "wet holes" could not be applied successfully to a cable drill designed for exclusive rock drilling, experimented with a view to building an equipment which would insure faster cutting abilities and at the same time build a machine to conform to the heavier equipment required in quarry operating.

Cable drilling machines as applied to quarry work must necessarily be a different type of machine than those used for water well purposes, insofar as the general construction is concerned, and must be made considerably heavier, as the abuse which equipment of this kind is subjected to in blast hole drilling is much greater in a continuous run of, say, two months than water well drilling equipment would be subjected to in the course of two years. Therefore, every part of the machine was designed as a unit to insure the highest efficiency and to conform to the requirements of that class of trade.

Industrial Notes

Mr. W. Millar has been appointed Canadian manager of George Anderson and Company of Canada, Limited, Montreal, makers of stone-cutting machinery, cranes, derricks gas engines, and gas suction plants.

The Southern Alberta Land Company, Limited, of Medicine Hat, Alta., are about to let the contracts for ditching portions of their irrigation scheme, involving some 700,000 cu. yds. of earth. In addition the company will do a large amount of concrete work, including the construction of reinforced-concrete headgates for two reservoirs, one of 300,000 acre-feet, the other of 30,000 acre-feet capacity. Mr. D. W. Hays is Chief Engineer.

Mr. Arthur E. Foulds has just opened a sales office in the Canadian Bank of Commerce Building, Brantford, Ont., as manufacturers' sales agent. He will carry a line of building materials, specialties and contractors' equipment. The experience with building supplies which Mr. Foulds has already had places him in a position to give good service, he having been for the past ten years on the executive staff of the Schultz Bros. Company, large contractors, of Brantford.

From the Canadian agents, Messrs. H. A. Drury Company, Limited, Montreal, we have received a copy of the Steel Sheet Piling Catalogue of the Lackawana Steel Company. The merits of steel piling are pretty generally recognized, but the booklet serves to illustrate the wide range of the application of the material in constructional practice. In a comparison of steel and wooden piling it is pointed out that steel is usually better even on comparatively easy work because it provides every strength element of tongue and grooved wooden piling and a joint-strength that is entirely absent with wood, while the increased transverse strength greatly reduces the amount of bracing required.

Canadian Allis-Chalmers, Limited, Toronto, have been appointed exclusive agents for Canada and Newfoundland of the Avery Automatic Scales. The parent factory at Birmingham, Eng., was established almost 200 years ago, and is without doubt the oldest and largest scale company in the world, comprising factories in England employing 5,000, and another at North Milwaukee, Wis. These scales are of the utmost value in power plant installation for checking the amount of coal and water feed to boilers, in weighing liquids for sugar and oil and other industries, and for use in cement plants to determine automatically the proper proportions of the various ingredients. The automatic grain scale is a recognized feature of every modern elevator and mill. The Avery Scale in the Canadian Government Elevator at Port Colborne constitutes the largest installation and the largest automatic grain scale in the world.

The Pneumatic Concrete Placing Company of Canada, have opened an office in the Transportation Building, Montreal, under the management of Mr. George W. Smith. The methods of the company for mixing and placing concrete through a pipe by use of compressed air are in favour in the United States. The ingredients are dumped into a conical steel shell and forced through an 8 in. pipe by air under pressure. The concrete is thoroughly mixed, and in practice has been placed at a distance of 1,100 feet and raised to an elevation of 80 feet above the mixer. Several plants are in operation in the United States, while the method has also been used at Niagara Falls, Ont., in the extension of the power house of the Ontario Power Company. The concrete lining of the Mount Royal tunnel of the C. N. R., Montreal, is to be placed in this manner. A large amount of concrete work is being done in Canada, and any process which will reduce the cost of the jobs, consequent on the small amount of labour and equipment, is of interest to engineers and contractors. The patent rights of the machine are held by the Pneumatic Concrete Placing Company of Canada.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **March 25, 1914** **No. 12**

Principal Contents

The Fire Hazard and its Responsibilities 347
Architecture and Environment 347
B. C. Engineers Active in the Interests of Professional Status 348
The Common Sense of Reinforced Concrete Design and Construction 349
Concrete in Irrigation Work in the Okanagan Valley, B. C. 350-8
By B. P. Little
The Application of Brick in Engineering Construction. 359
By E. E. R. Tratman.
Present-Day Practice in Concrete Road Construction. 360
Recommendations for Concrete Road Building 361
Relative Economy of Constructing Bituminous Concrete Pavements and Bituminous Pavements by Penetration Methods 362
By George C. Warren
Portable vs. Stationary Asphalt Plants 363
By J. W. Astley, C.E.
Examples of Poor Design and Improper Operation of Small Water Purification Plants 364
The Design of Sewage Treatment Works in Saskatchewan 365
Power Development at Saxon Falls 367
The New G. T. P. Hotel at Edmonton 369
Concrete and Concrete Mixers 370
Personal Mention, featuring:
  Sir Robert Perks, Bart. ... ...
  Mr. George D. Mackie ... ...
  Mr. E. D. Gray 373-4
Montreal Harbor Commissioners' Activities 377
Constructional and Industrial News 375-8

The Fire Hazard and Its Responsibilities

WITH an investigation in progress at the time of writing, it were un-British to launch into criticism of any of the interests concerned in the tragic fire at the Woodbine Hotel, Toronto, last week, but the occurrence is too serious and too far-reaching in its importance to pass unnoticed. The loss of several lives at an early hour of the evening when there should have been ample opportunity to secure orderly exit from the building demands at least passing mention in a journal which stands for the principle "Safety First" wherever human lives are a factor in the argument. Since the conflagration, the Woodbine Hotel has been criticised as "a jumble of factory and office buildings fashioned into the similitude of a modern hotel." The building has been condemned freely as a "fire-trap," and, in the articles which have appeared in the daily press, reflections have been cast upon nearly everybody except those who were unfortunate enough to be cremated. From the facts which have come to light it may be natural to conclude that the construction of the building could not comply with the requirements of any well-considered, conservative by-law, that the height of the addition to the hotel made last year exceeded that provided for in the city ordinance, and that the facilities for escaping from such a building were inadequate. One is disposed to think these things, but not to pass them on as judgments. Such judgments would be untimely, unjust. Extravagant and gratuitous criticism does not impress a lesson of this kind. It is only by fixing upon the defects, centralizing and amending them, that we can evolve order out of chaos, improvement out of calamity. We are entitled to know—and we must know—under what authority the use of a remodelled factory building of ordinary joist construction was sanctioned for hotel purposes. It is incumbent upon us to ascertain in what respects our legislation requires enlarging so as to make adequate fireproofing and means of rapid exit indispensable in the construction of all buildings of a public character. Efficient inspection must be our watchword. And we must see to it that that inspection is not concentrated upon the sustaining power of the structure, but that it provides protection against that element of fire so destructive of human life—that element which has contributed so much to making the American continent notorious for fire tragedies.

Architecture and Environment

WHILE it may be somewhat beyond the province of this journal to enter into an extended discussion of any particular phase of architecture, it is nevertheless open to us to consider the subject in the general sense of its relation to environment. We are all the more disposed to devote a few thoughts to the subject, having in mind many buildings that have been erected of late in our leading cities—structures which, while generally commendable in their design and equipment, bear little or no evidence of thought in regard to their surroundings.

It may be urged that the problem of adapting a structure to its locality and the neighboring buildings presents peculiar difficulties in Canada. With this we are in accord, but the most superficial examination of the widely varying types of structures in Montreal, Toronto, Winnipeg and Vancouver shows that the question of environment has been almost a negligible factor.

In a recent editorial we commented upon the mistake of hemming in a restricted area such as that enclosed by the four corners of King and Yonge streets, Toronto, with skyscraper buildings twenty storeys high. Several readers took issue with us over our statements, but we cannot but think that they did not give due consideration to the subject of environment. In this conviction we are strengthened by the reading of an address on the subject, delivered recently in London before the Architectural Association, by Professor Perchon, who emphasized the fact that for a building to be really beautiful it must be adapted to its surroundings in regard both to materials and to design. Professor Perchon dealt with the subject chronologically, showing how buildings erected in the various periods had developed on lines suitable to their surroundings, climatic conditions having a most obvious effect. He concluded with the following significant observation:

> "Our responsibility is a great one, for, while the influence of ugly and sordid buildings is degrading, and that of a sham, forced architecture is, at the best, ineffective and inoffensive, the influence of a genuine architecture on all who come into contact with it is uplifting and ennobling."

The principle is a sound one. It is one upon which all constructional enterprises should be carried out. Undoubtedly the better we make our public buildings, bridges, streets, parks and houses, the more likely we are to build up a nation. Is it possible to outrage one's senses more violently than to find in the short space of three blocks, on a main street, a dozen buildings all different in height and type and material? In a discussion of Professor Perchon's paper one of those present spoke of "horrible concoctions in red brick" and "dreadful abortions in terra cotta." One cannot help wondering in what terms this man would describe some of our best work of the last decade—work whose sole merit, in most cases, has been individuality in design, but possessing no unity and totally unfitted to its environment.

It may be objected that an outsider has no right to criticize architecture. Such a principle is wrong. Outside influence and criticism have always played a part in all professional work. Too often the architect becomes so highly developed in the artistic sense that he is most deficient in every other. He falls into the most elementary errors in planning and gives no evidences of realizing that the fundamental factors in architecture, as described by the authority mentioned above, are "the proper uses of materials, sound construction, sanitation, and suitability to purpose and surrounding conditions."

B. C. Engineers Active in the Interests of Professional Status

THE British Columbia members of the Canadian Society of Civil Engineers have recently shown considerable activity in endeavoring to get the status of the Engineer recognized by the Provincial Government. In view of much new legislation involving large engineering projects, several influential deputations of the members headed by Mr. F. C. Gamble, Chief Engineer of the Department of Railways, and Mr. G. R. G. Conway, Chief Engineer of the British Columbia Electric Railway Company, Limited, the respective Chairmen of the Victoria and Vancouver Branches, met the Premier, Sir Richard McBride and the Executive Council and laid before them very strongly the views of the Western members.

It was pointed out that in numerous Acts of Parliament, the definition of an Engineer was extremely unsatisfactory. One example given was quoted from the "Ditches and Water Courses Act, 1907" where an Engineer is defined as follows:—

> "Engineer" means Civil Engineer. Provincial Land Surveyor, or such a person as any Municipality may deem competent and appoint to carry out the provisions of this Act."

The effect of this definition in one instance in British Columbia was the temporary appointment by resolution of the Municipal Council of a small contractor to design plans, and the deputation pointed out to the Ministers that there was nothing in the Act to prevent a Municipal Council from appointing a gardener, blacksmith or carpenter to carry out the duties of the Act as Engineer.

The deputation were accorded a very sympathetic hearing from the members of the Government, and many private members supported their proposals.

Subsequent to the interviews with the Government, a petition was sent to the Premier signed by every leading Engineer in the province, asking that the word "Engineer" should be defined in the new Water Act as follows:—

> "Engineer means an Engineer of the Water District, who shall be a Civil Engineer who is a member of the Canadian Society of Civil Engineers, or a member of the Institutions of Civil Engineers of Great Britain or of Ireland, or a member of a Civil Engineering Society of equal rank in the British Empire or any foreign country."

This definition was accepted by the Minister of Lands, the Hon. W. R. Ross, who, however, felt that while entirely recognizing the principle of the definition, and in expressing himself in hearty accord with the objections of the members of the Canadian Society, he thought that special circumstances might arise in which he might be hampered by too strict an observance of the definition. He therefore suggested the addition of the following words, a suggestion which was mutually agreed upon, and now, together with the foregoing, forms part of the Water Act of 1914.

> "But the foregoing definition shall not limit the power of the Lieutenant-Governor-in-Council or the Minister to appoint to any position created under this Act, any person who is in his opinion competent to fill such position."

The Western members feel that they are to be congratulated upon the success of their efforts, and hope during the next session to have a similar definition incorporated in the Municipal Act, the Railway Act, and other Acts dealing with engineering undertakings.

In discussing the construction of concrete buildings in a paper before the Boston Society of Civil Engineers, Leonard C. Wason, President of the Aberthaw Construction Company, Boston, Mass., advises casting the stairs considerably later than the floors, and in a separate operation.

The Common Sense of Reinforced Concrete Design and Construction

In an interesting paper devoted to the above subject delivered last month before the members of the Ipswich (Eng.) Engineering Society, Mr. H. E. Steinberg, Assoc. M. Inst. C. E., dealt mainly with the fundamental principles which were common to all systems of design and all types of reinforcement. Owing to the number of so-called inventions with which reinforced concrete was beset, he said it would be most useful if he gave his audience some idea as to how the relative worth of the various methods and designs could be appraised and their practical value judged in one consistent manner. In England practically no experimental work worthy of the name had been done, though a few badly-designed beams and columns had been broken at various times by isolated enthusiasts. He spoke of the disappointment caused by the first Report of the Institution of Civil Engineers, though the second Report contained an account of some ingeniously-planned experiments by Dr. Unwin on plain and reinforced, square and rectangular concrete slabs. In all foreign countries where building was in progress the use of reinforced concrete appeared to be very extensive, especially so in places liable to earthquakes, as the reports of the San Francisco disaster showed that the reinforced buildings withstood both the earthquake and the subsequent fire more satisfactorily than the steel skeleton buildings. With reference to the practical details of construction, he first observed that it was chiefly the cheapness of the material which, other things being equal, had made it so phenomenally successful. He laid it down that if the same unit stresses were specified and worked to by all designers, then the cost of practically all systems must be approximately the same for any particular structure. At the same time he asked them to observe that, though there might be little difference in cost between designs they might vary in merit, either by the actual details of the arrangement of bars, etc., or by the general engineering ability underlying the design. The bending moment in a beam might be calculated accurately for each span and over each support, with all the meticulous niceties of the theory of continuous beams, or, on the other hand, a simple, easy fraction like WL/10 might be taken for the bending moment in the span over the supports and anywhere else. In either case the cost of the job would not vary much, but in practice the latter design would develop cracks, whilst the other would have a uniform factor of safety throughout. From this point the lecturer went into still more technical details, in order to explain the common-sense principles underlying all systems of reinforced-concrete design. Amongst the matters alluded to were the extent to which concrete might be safely relied on to stick to steel so that they could arrange for their reinforcement to have sufficient superficial surface, in proportion to the cross-sectional area; of how to increase points of weakness by widening the beam by embedding reinforcement, or by increasing the depth of the beam. It was a simple matter to say that this part would be in tension, that in compression, and that the other was trying to slide relatively to another part; but it was not so easy to determine how many tons' tension there might be there, how many pounds' compression there, and exactly to what extent one portion of the concrete was sharing in respect to another. These, however, were the problems which must be solved by every designer, and the merit would depend on the accuracy of the various solutions. After showing the advantage of reinforcing by spiral and other methods, he concluded by saying that the future would be with the specialist designing firms, with a greater tendency to specify a system of design so that the firms would be able to lower their fees. The largest amount of work would accrue to those firms whose reputation was the best for turning out designs accurately, clearly, and quickly.

Electrical Driving of Winding Engines and Rolling Mills

At the last meeting of the Canadian Society of Civil Engineers, Montreal, Mr. C. A. Ablett, A. M. Inst. C. E., Manager of the Siemens Company of Canada, Limited, and Mr. H. M. Lyons, A. M. I. E. E., presented a paper on the above subject. The paper dealt in a comprehensive manner with electrical machinery for driving hoisting machines and reversing rolling mill plants in steel works, and described the Ward Leonard and Ilgner systems. The various safety devices were also described, the authors expressing the opinion that the Ward Leonard or Ilgner system of electric winding is the most suitable for vertical shafts and for all cases where large outputs are required and short and frequent winds are made. The three-phase winder always has the disadvantage that it cannot be so completely protected against careless handling as either the Ward Leonard or the Ilgner, but it may prove more economical for long slopes where the full speed run is a long one and the periods of acceleration are comparatively infrequent. Direct current is much better adapted for driving mills and machinery in a steel works than three-phase current. Where large reversing rolling mills are driven electrically, and the motor driving the motor generator set is supplied from a direct current system, it is found that the power supplied to the rolling mill plant can be maintained at a much steadier value than if it is supplied from a three-phase system, and with the direct current motor about a ten per cent. saving in power can be effected, as there is no loss of power in slip resistances.

In a paper read to the American Society of Mechanical Engineers, Mr. G. E. Fisher, of the Arkwright Fire Insurance Company, says that the best fire-resisting materials for concrete are usually considered to be first-class Portland cement, with quartz sand and broken trap rock. Cinders make a good aggregate for fire resistance; but the concrete made with them is not so strong as rock concrete, and cannot be used where high compressive values are necessary. Considered from an insurance point of view, cinder concrete is not desirable, on account of the porous quality of cinders. The insurance companies have learned that with cinder concrete they are called upon to pay losses on account of damage from water used at times of fire, which percolates through the small interstices of the cinders (which the cement mixture cannot reach) to the floors below.

President Wilson has signed the bill authorizing the expenditure of $35,000,000 for the first government-owned railway constructed for the United States. The President said that the enactment of the railway bill would be followed by the passage of the Alaska leasing bill; which would mean the carrying out of the administration programme for the development of Alaska in a short time.

Concrete in Irrigation Work in the Okanagan Valley, B.C.

By B. P. Little, C.E., Manager B. P. Little Construction Company, Limited, Kelowna, B.C.

THE irrigation works of the South Kelowna Land Company, Limited, of Kelowna, B.C., contain many points of constructional interest. The article presented herewith is devoted primarily to a description of concrete-lined canals and concrete pipe laterals, the latter being under heads ranging from zero to 140 ft.

General Scheme of Layout

The system was planned by and the work executed under the direction of Mr. F. W. Groves, C.E., B.C.L.S., Chief Engineer for the South Kelowna Land Company. The land to be irrigated embraces a tract of irregular outline containing about 4,000 acres lying on the east side of and overlooking Okanagan Lake, and is situated in the famous Okanagan Fruit Belt. The water for the system is conserved in a natural basin lying on the height of land between the Kettle River and Okanagan Valleys, at an altitude of 4,170 feet. The storage of water is accomplished by constructing four earth-fill dams across as many outlets to the basin, two of which have already been built. The others will be added from time to time as additional storage becomes necessary. The ultimate storage will amount to 10,658 acre feet, about one-third of which is now available.

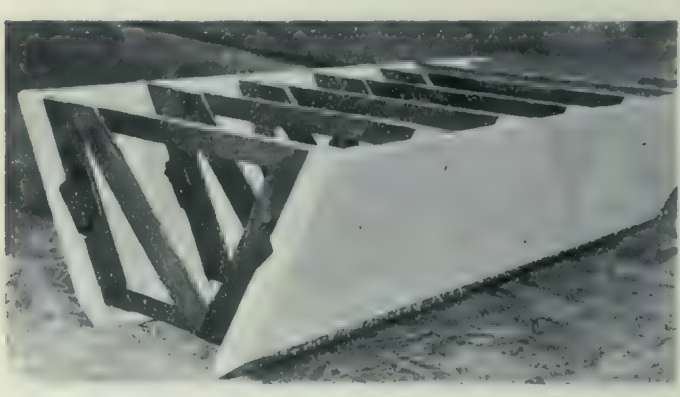


Fig. 1.—Forms for canal lining assembled.

The principal dam, No. 2, is situated about sixteen miles easterly of the centre of the tract to be irrigated and is approximately 600 feet long on top and will be 34 feet high at centre. It is now 24 feet high. The top width will be 16 feet, with inside slope of 1 on 2½, and outside slope of 1 on 3, with a puddle core averaging 6 feet in thickness. The main sluice-way is a concrete conduit, reinforced with triangle wire mesh. The flow is controlled by iron gates from a reinforced concrete gate tower. The spillway is located near another dam (No. 3) about a mile distant from Dam No. 2 and will be a concrete-lined raceway discharging on to rock.

From the main dam the water flows westward in the channel of Hydraulic Creek, a distance of twelve miles, more or less, to a small concrete intake dam located in a deep rocky gorge, bedded and buttressed on solid rock. This intake dam forms the headworks of the distribution system. From this headworks to the rim of the Canyon the water is conducted through a wood stave pipe 32 in. in diameter for 3,800 feet, the maximum head on pipe being 132 feet. At the end of the wood stave pipe begins the canals and the concrete pipe system which is the particular subject of this article.

Section No. 1 of the main canal begins at the end of wood pipe and extends westward a distance of about three miles to the crossing of Canyon Creek. This portion of the canal is located on very difficult ground, along the faces of almost vertical cliffs, steep bluffs of cemented gravel and clay and other difficult features. Access to the line of canal with vehicles was only possible at distant intervals and then only at a heavy expense for "tote" road building.

The canal has a calculated discharge of 75 sec. ft. on a grade of 0.15 per cent., the finished dimensions being 3 ft. wide on bottom, 3 feet deep, with side slopes of ½ on 1, making a top width of 6 ft. The canal is lined throughout with 3 in. of concrete. Canada Portland Cement was used for all concrete work described herein. Careful computations were made of various sections for this canal to determine the most economical shape of cross-section, and it was found that the best section was to make the depth and bottom width equal, with side slopes of ½ on 1, considering the cost of excavation, cost of concrete lining per cu. yd., and the mean hydraulic radius.

Soil Conditions

The ground traversed by Section 1 of the canal having been described, in a general way it may be said that this description applies as well to Section 2, except that the land is less precipitous. Below Section 2 and over the whole tract the soil consists of light sandy loam, with some gravel admixed in places. The rock along the upper reaches of the canal is greatly shattered and seamed, and the clay bluffs when saturated are very unstable, so it was early decided that the canals should have impervious linings, not only to prevent great waste of water by perculation, but to perserve the integrity of the canals.

The Provincial Water Commission allows 2½ acre feet per acre per season for this district, measured at the head gate, and any considerable loss of water would be inadmissible. Consideration was given, too, to the deleterious effect of escaping water upon the

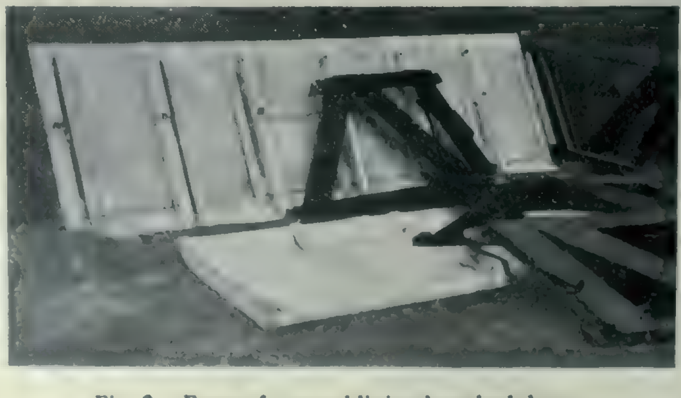


Fig. 2.—Forms for canal lining knocked down.

lands lying below the ditch lines. This water usually travels below the surface as ground water dissolving the alkaline salts from the earth in passing, until the water finally rises to the surface and evaporates, leaving behind the salts to form "alkali" and destroy the fertility of the land. With an ingenuity that seems devilish, this water almost invariably selects the most fertile bottom land or most highly-cultivated field in which to make the deposit, and the best land is soon useless. This danger to the land is a most insidious one that may not be recognised (probably will not be by the uninitiated) until too late to rehabilitate the soil. This trouble from percolating water has become so pronounced under some of the older U. S. irrigation systems, and in one, at least, of the Okanagan Valley systems, that owners of damaged lands are either threatening or have started damage suits. It is probable that state and provincial laws will take cognizance of this evil some time and require that all irrigation water ways shall have impervious linings, but probably not until a few more million dollars' worth of damage has been done.

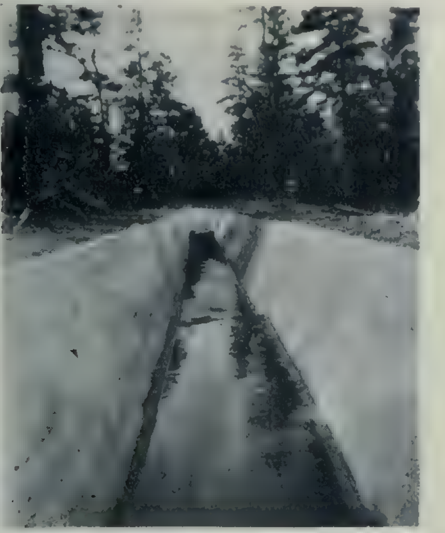


Fig. 3.—Canal two years after construction.

The crossing of Canyon Creek is made with a rivetted steel pipe inverted syphon, with a mean diameter of 28 in. and about 2,000 feet long. The canyon at this point is a rocky gorge about 375 feet deep and 1,200 feet wide from rim to rim, but the syphon does not cross it directly at right angle with its direction. The maximum head on the steel pipe is approximately 360 feet.

Section 2 of the main canal extends from the syphon westward for about 4,500 feet, where a drop of 350 feet is made to a lower level by means of a 24 in. concrete pipe, 2,600 feet long, to Section 3 of the canal. At this point advantage was taken of a natural depression in the ground to form a small reservoir for "balancing" the flow in the canal. This reservoir forms the headwork of lateral No. 2. It has a capacity of about 6 acre feet.

Section No. 3 of the canal extends westward from the foot of the above-mentioned "downtake," a distance of about 1 mile. It will be extended several miles further as required. From this section the lateral distribution is made. This will ultimately consist of seven laterals with a combined length of approximately 150,000 feet, or about 28½ miles.

The topography of the tract is such that open ditches and flumes would require indirect routes and extensive trestling, involving high maintenance charges, attendant loss of water and damage to land. Therefore, pipe lines, following closely the undulations of the ground and taking the most direct courses between objective points, were selected as the economical solution. Wood, steel and concrete pipes were considered and costs estimated, and the selection fell on the last-named. Wood pipe gave the lowest estimate of first cost, but its life for irrigation work in the Okanagan Valley is proving to be very short, probably not to exceed nine or ten years, although no exact average figures are available yet. This failure is owing to dry rot, probably due to the pipes being empty from seven to eight months in the year, and in a few instances by the wire wrapping corroding.

Steel pipe does not differ much from concrete pipe in first cost, but it promises to be short-lived. All the irrigation water used in the district is very severe on steel or iron, this being attributable to carbonic acid gas arising from the oxidation of the vegetable matter in the swamps at its source. No paint or coating, thus far, has been able to prevent this water from pitting and corroding the steel of pipes or the castings of gates, valves, etc. From present indications it is very doubtful if the life of steel pipe will exceed that of wood pipe in the same service.

Concrete in various forms has been used in irrigation works in the Kelowna district for a number of years—antedating either wood or steel pipe. No signs of disintegration have become visible, and no doubt of its suitability or permanence has been felt. Concrete pipe was therefore adopted in this instance for the distribution system.

Details of Construction

The main canals were excavated as nearly as possible to the exact outside dimensions of the concrete lining, but were generally from 0.1 to 0.2 feet larger in width. Great care was taken to get the bottom dressed precisely to grade. This was accomplished by keeping the bottom 2 or 3 inches high in the first excavation and doing the final dressing after the bottom grade hubs had been set, as described below.

The alignment of canals was such that the entire bottom was in solid earth as far as practicable. To make the cut and fill balance it generally required a cut of 7 of 8-tenths of a foot at the lower side of the bottom. Considerable refinement was given the location so that the excavation of the ditch, a berm two feet wide on upper side and the side hill slope excavated above berm would just build the fill, with a berm of 2 feet on the lower side of ditch. The excavation was nearly all made with pick and shovel, drag scrapers and ploughs being used in only a few places, and then

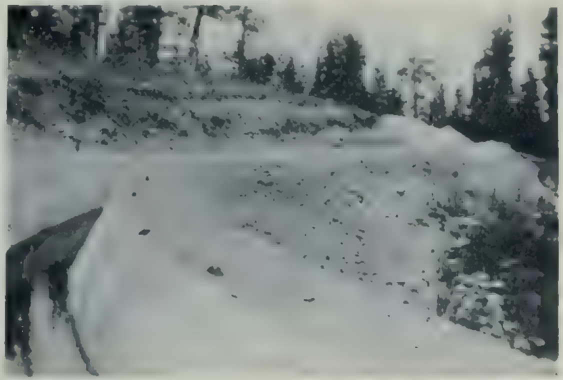


Fig. 4.—Canal showing curve alignment—two years old.

with no gain in economy. The alignment consists of tangents and circular curves run in with a transit. After the rough excavation was made, the centre lines of tangents were re-run and curve points re-established, but around the curves the concreting was allowed to follow the excavation as first made. Grade hubs, with tops driven to the finished top of cement lining, were set every 15 feet on both tangents and curves, and the final dressing of bottom was then made by measuring down 3 in. from the top of stake. These hubs remained as a guide to the form setters.

Forms

Forms for the canal lining, designed by the writer, were of a "knock-down" type and are shown assembled in Fig. 1 and knocked down in Fig. 2. They were built in sections from 6 ft. to 12 ft. long, each section consisting of two sides and a number of cross frames spaced 2 ft. apart. The sides were made of ⅞ x 4-inch matched pine flooring, nailed to 2 x 4 studs on 2-ft. centres. The cross frames were made of 2 x 4 stuff with 1 x 6 in. bracing. The lower cross bar was kept 4 in. in clear above the bottom of finished concrete, to allow trowelling under the cross frames. These crossbars proved rather light, and would have been better made of 2 x 6 in. scantling; still, after two seasons' work these forms are very serviceable and will be used in extending the main canal. There were built 1,400 lineal feet of these forms, the cost being $1.15 per foot, with lumber at $20 for the sized material and $28 for matched flooring, carpenters at 40c an hour. The exterior surfaces were coated from time to time with California crude oil, to prevent the concrete from adhering.

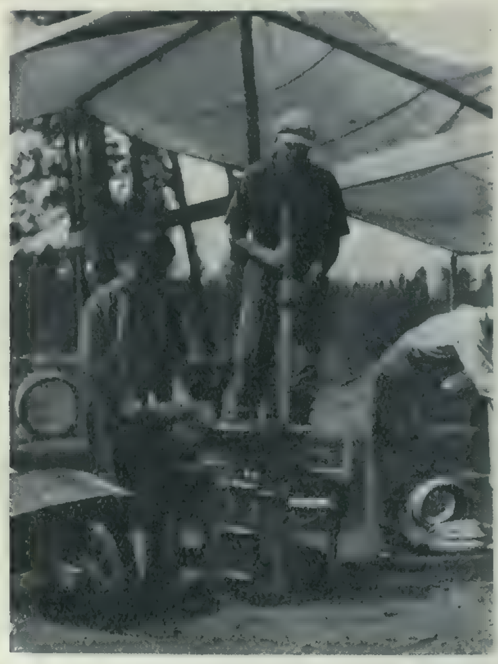


Fig. 5.—Use of air compressor for tamping concrete in pipe moulds.

After the forms were distributed along the berm, a gang of four men were able to assemble and line up 500 feet of forms per 10-hour day. The procedure was for two men on the berm to hand the parts down to two men in the excavation, who assembled the forms. Then the assembled forms were aligned and blocked up to grade and each was attached to the last preceding form with two bolts, one on each side, to prevent end motion. On curves a strip of galvanized sheet steel was placed over the opening between the adjoining forms, as they would touch only at the top on the inside of the curve. The construction of these forms is shown quite clearly in Fig. 2. There were hardwood pins in the top and bottom of each stud projecting ¾-inch from the side of the stud, and mortices in the ends of the cross bars that engaged these pins, and a hardwood button on the side rib of the cross frame that entered a notch cut in the side of the stud. When assembled the forms were rigid and each complete form could be handled as a unit.

Outside of the forms, between the forms and the side of the excavation, battens of 1½ x 3 in. pine were stood up at about 18 in. centres, and outside of the battens were placed sheets of 10-gauge steel, about 3 x 4 feet in size. When the concrete of side lining was being placed, the sheets were pried up against the battens and earth was tamped in between the sheet and side of excavation at the same time as the concrete was being rammed between the battens, the battens and steel sheet being raised as the filling advanced, so that when the space was full the battens and sheets were fully removed and ready to use again. This gauged the thickness of just 3 in. of concrete, and also prevented the concrete tampers from mixing earth with the concrete. The only objection to this arrangement was that the earth back of the sheet could not be rammed as hard as it should be without raising the forms (even when loaded with the concreting paraphernalia and several men) and the filling had to be gone over again the following spring and retamped. It was found that this filling had become so slack in places that the side lining had settled outwards, causing incipient cracks, but after a thorough retamping no further trouble was experienced. Sections 1 and 2 were placed in 1911.

When placing the lining the concrete was wheeled in barrows from the mixer on planks laid on the tops of cross frames of forms. The bottom was put in first, and a workman floated this up to the surface and trowelled it. As soon as the bottom was in, the sides were concreted. To do this, the wheel barrows were dumped on a steel plate on the plank runway, and the material was shovelled into the space between the battens. The lining was divided into sections of about 15 feet by placing strips of thin sheet iron, 3 in. wide, on edge across the bottom and up the sides. These strips were left in and formed contraction joints. The blocking under the forms was removed as the concrete bottom was put in. The forms were allowed to remain for twenty-four hours, when a gang of four to six men knocked them apart and passed them out onto the berm, then patched any rough or broken places in the

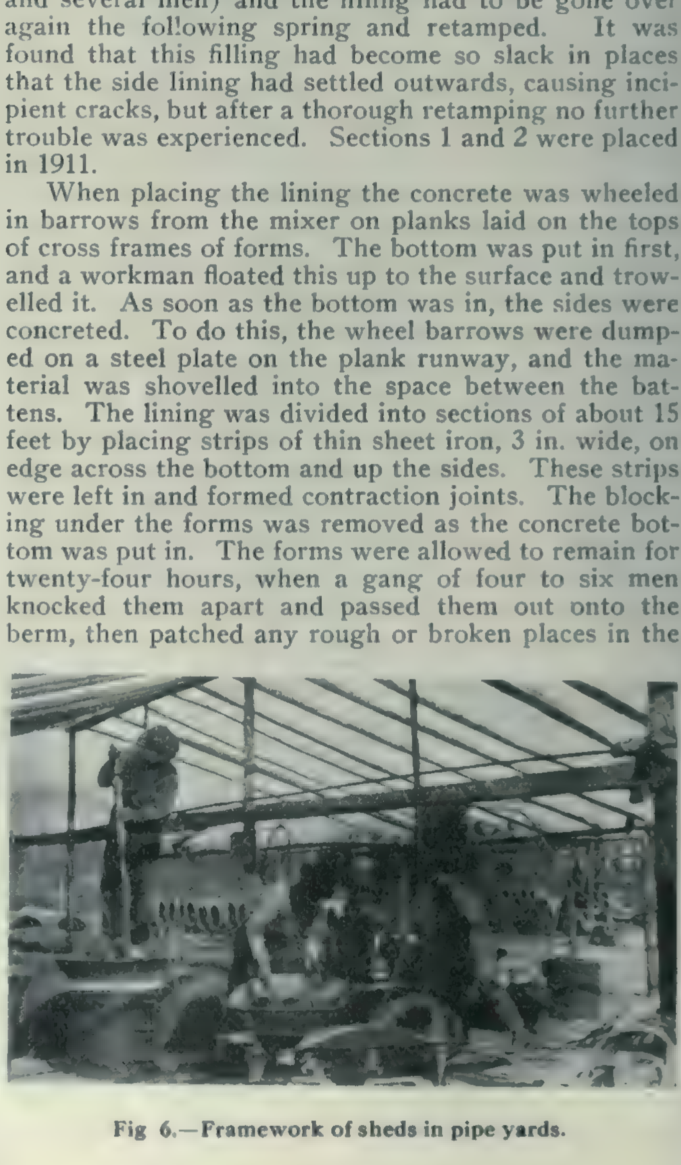


Fig 6.—Framework of sheds in pipe yards.

concrete and finally gave it a brush coat of cement grout. The lining was then covered with burlap and sprinkled occasionally for the remainder of the day. The following day the burlap would be moved ahead, a temporary bulkhead of plank placed at the lower end of the completed section and the bulkhead at the foot of the preceding day's work removed or holes bored in it, and the ditch allowed to fill with water. One or more times during the day, and possibly the following day, a man would go along the berm and splash the water up to the top of the concrete, but after the second day little attention was paid to it, the capillary attraction being sufficient to keep the top of the concrete wet.

As the finishers removed the forms, a gang of laborers carried them ahead to the form setters, except where a wagon could approach the canal, when they were transported in that way. Water for mixing was raised from behind the bulkhead with a small gasoline pumping engine and was sent forward to the mixer through 2 in. wood pipe, which was taken up behind and relaid ahead as occasion demanded. A gang of forty men in all could average about 400 feet of lining a day, with now and then a spurt of over 500 feet. The latter figure corresponds with an output of 50 cu. yds. a day, as the cross-section of the concrete is 2.7 sq. ft., or 1/10 cu. yd. per foot.

The concrete was 1:3:6 mixture, using 10 per cent. of hydrated lime, and gravel aggregate, mixed in a drum batch mixer. The cost of lining was from $15 to $18, the cement costing about $4.50 per bbl. delivered at the ditch. The high cost of concrete is due principally to the difficulties encountered in getting material distributed, including cost of "tote roads."

Observations as to Durability After Two Years

As noted elsewhere, the first and second sections were lined in 1911 and are now over two years in place, and it is possible to draw some conclusions as to the durability of this lining, cost of maintenance, etc. The following important repairs have been made. The earth along the side lining has been retamped over a large portion of Sections No. 1 and 2 and to a lesser extent on Section 3.

About 60 feet on one side of Section 1 was wrecked in the spring of 1912 by a mud-slide. The side lining happened to project an inch or more above the berm and when a heavy clay bank above it, slid, it caught this exposed edge and turned the side over into the canal. No harm was done to the bottom or opposite side. The bottom heaved up and had to be replaced for a distance of several hundred feet on Section 2 during the winter or spring of 1912. This portion of the ditch was through a thorough-cut in hardpan. The old bottom was cut out, drain tile laid in a trench evcavated below the bottom, covered with gravel and a new bottom put in. The drain tile extended out of the cut and was carried out to the surface down the hill from the canal. Some further repairs were necessary the following spring (1913) some cracks developing that were plastered over. This cut will probably require annual repairs if the lining is to be kept intact, but owing to the imperviousness of the soil there it would hardly seem necessary to try and keep this particular cut up to standard maintenance.

In addition to the above, some cracks have been grouted and berms levelled up to top of concrete, etc. —mostly done at odd times by the ditch walkers. Excepting the clay cut there are no defects that indicate that the lining will not last for years. The annual maintenance will be practically nil. Those portions of the ditch that are located wholly or almost all on rock fills show the fewest defects. The portions that are partly on fill are in the next best condition, and so on until the poorest parts are in full cut sections in heavy earth. This of course is due to the under-drainage where location is on fill or mostly fill. If thorough cuts in heavy earth are necessary it would be better to construct a closed pipe or conduit, which could be backfilled, and by closing the ends of this section with boards or brush and leaves in the fall the frost could be kept out from below the bottom. Figs. 3 and 4 shows views of the canal at the age of two years. The photographs were taken when about 1-inch of water was running in the ditch.

Lateral System of Concrete Pipe

As noted elsewhere, the lateral system is constructed of concrete pipe and will eventually embrace about 150,000 lin. feet of pipe, about half of which has already been supplied.

The general specifications for the pipe with unit working stress for unreinforced pipe, and the unit stress in steel in reinforced pipe were worked out by the engineer and the contract for its construction given to the B. P. Little Construction Company, Limited, of Kelowna, who designed the details and methods of manufacture.

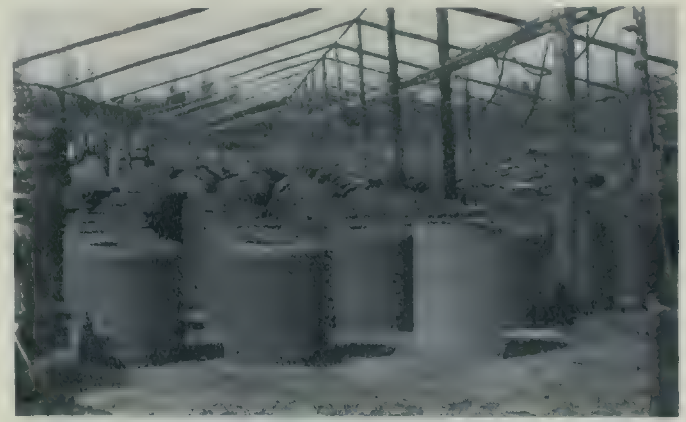


Fig. 7.—Completed pipes.

The pipe for lateral No. 5, with a length of approximately 35,000 feet, was installed in 1912 and the spring of 1913. The trenches were excavated and the pipe made for lateral No. 2 in 1913, but the pipe has not yet been laid in place. The pipes range from 6 in. to 30 in. in size, and are all made in sections 2 feet long, with bevel and tongue joint.

The plant for the manufacture of the pipe consisted, in addition to the usual steel pipe moulds and cast iron rings, of a 20 h.p. gasoline engine belted to an 8 in x 8 in. air compressor, with 24 in. x 6 ft. receiver, six compressed air concrete rammers, one comperssed air chipper, power driven punch and shear and power driven bending rolls, batch mixer, screens, etc.

A pipe yard about 150 x 350 feet was nicely levelled off and a rough framework of poles was put up as shown in Figures 5 to 10. Three "sheds" were erected of these poles, each 30 x 300 ft., with driveways along each side of each shed. A one-inch water line under 50 lbs. pressure and a ¾-in. air line under 80 lbs. pressure was placed along the centre of each shed, each pipe line being provided with hose tape every 30 to 40 feet.

Each pipe-making gang working in these sheds was provided with a canvas cover of 10 oz. duck, 24 x 40 feet in size, which was stretched over the framework, and under which they worked, thus protecting the fresh concrete and newly made pipe from the sun. As the gangs advanced through the sheds the canvas was moved forward.

As soon as the pipe would stand wetting, without washing away, they were sprinkled, and an expert waterman could begin giving them water within a half hour after the moulds were withdrawn. In warm weather a spray could be kept on them after they were three or four hours old. As soon as the pipes reached this set sprays from garden sprinklers were kept on them and they were not allowed to become dry again until cured—a matter of twelve or fifteen days, depending on the weather. Dozens of these sprinklers were in use all the time. One man devoted all his time to their attention, with an assistant about half the time.

The pipe was specified to be made of a 1:2:2 mix, using gravel aggregate, not larger than one-half the thickness of the shell of pipe, with the addition to the cement of twelve per cent. of its weight of hydrated lime. For some portions of the pipe a 1:1½:1 mix was used, as in the reinforced pipe of small diameter the shell was so thin that the gravel had to be very small to pass the reinforcement—in fact a mixture of 1 cement to 2½ sand better expresses the composition.

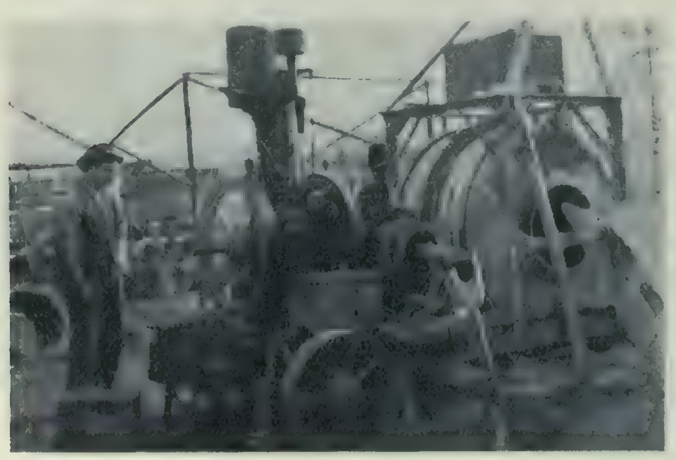


Fig. 8.—Concrete mixer used in manufacturing pipes.

The mixture was turned over dry for one minute in a batch mixer (Fig. 8) and then water was added to bring the total moisture up to about 18 to 19 per cent. of the weight of cement. Dry sand was preferred as it gave a more uniformly dry mix, and it was generally possible to keep the sand practically dry. The resulting batch with the above amount of water would just stay up in a ball when patted together in the hands, but under the power rammers moisture would be forced out of it and deposited as a heavy dew on the walls of the moulds. The endeavor was to have the mix as wet as it could be made to stand up when the moulds were withdrawn immediately after forming the pipe. With reinforcement a considerably wetter mixture was possible.

Under 80 lbs. air pressure at the receiver the rammers ran at a speed of about 400 blows a minute, with air cylinders 1¼ x 5 in., the usual stroke being about 4 inches. As near as could be determined there was about 40 lbs. average effective pressure in the machine. The weight of moving parts was approximately 8 lbs., the momentum of which was effective in adding to the force of the blow. The combined ramming effect may be estimated at about 92,000 inch-lbs. per minute. The resulting pipe was dense and homogeneous, the unreinforced pipe weighing at the rate of 148 lbs. per cu. ft. of concrete, for smaller sizes to 152 lbs. per cu. ft. of concrete for larger pipe. Ordinary wet-mixed concrete of the same material ran about 142 lbs. per cu. ft. The freshly moulded pipes were allowed to remain standing undisturbed on the cast iron ring forming the bottom of the mould for a period of from twelve to thirty hours (sometimes longer) depending on the weather; then they were turned down on their sides and the rings removed.

The pipes were allowed to lie in that position, under sprays of water, for several days, or until the space occupied was again required for moulding, when they were "corded" up along the driveways until curing was complete. Then they were hauled out to the trenches. There were nine sizes of pipe and three to five "classes" of each, the class referring to the amount of reinforcement, there being 34 varieties in sizes and classes altogether. To prevent any possible confusion, each piece of pipe was marked, soon after it was made, with the date and class, using lampblack mixed in kerosene oil. These markings remain perfectly legible after eighteen months' exposure to the weather. Fig. 9 shows 30 in. pipe standing on a ring, and Fig. 10 the same pipe turned down and the ring removed.

Unit Stresses and Reinforcement

The maximum static head allowed on unreinforced pipe, referred to as "plain" pipe herein, was that due to a tensile stress of 60 lbs. per square inch. This stress, however, occurs but in a few places on small pipe. The more usual limit strain was 40 lbs. per sq. in.

Reinforced pipe was used where the stress would exceed 40 lbs. per sq. in. in the concrete (except in a fe winstances as noted) and the reinforcement was figured to take all the strain at a factor of 8.000 lbs. per sq. in. This low factor was used for the following reason: The steel is placed in the shell of the pipe simultaneously with the concrete. The concrete in curing will shrink somewhat and the hoop is thereby put under compression. With a wet mix this shrinkage is considerable, and with the moist mixture described above as used on this job the shrinkage is perceptible. When pressure comes on the inside of the pipe the concrete must "give' 'either by its elasticity or by the development of hair cracks before the steel will begin to take strain in tension. If the stress on the steel were sufficient to stretch it appreciably a leaky pipe would be expected. Take for instance a 20-in. pipe with hoops 22-in. in diameter; the extension in circumference of the steel at 8,000 lbs. per sq. in. would be almost exactly 1-64 of an inch, which would probably be divided between several hair cracks around the circumference of the shell. These cracks would not open enough to leak, but if the yield were much more than that amount the cracks might become more than "hair cracks." As a matter of fact it was found in testing reinforced pipe in the testing machine in the yard that if the pipe had become well dried out, and the pressure were run up immediately, the test piece would crack from end to end at about the breaking strain of plain pipe, but after a few minutes this crack would cease to leak and the full test pressure could then be put on gradually. If the water were allowed to stand in the pipe for a time, as over night, before the pressure were run up, it would then test well above working pressure without cracking at all, the explanation being that the concrete would "swell" or expand enough to put an initial stress on the hoops. The testing outfit was rather crude and in the writer's opinion the results obtained from it were not dependable. It might be misleading to publish the figures, but from the tests the conclusion was drawn that at from 10,000 to 11,000 lbs. per sq. in. stress in the steel, the concrete would begin to show hair cracks, although these would not often leak until 11,000 lbs. was exceeded.

The testing machine consisted of bulkheads with rubber gaskets placed over the ends of the pipe, drawn together with through rods parallel with and outside of the pipe. In order to prevent leakage at the gaskets, it was necessary to draw these rods very tight. There was no way of estimating this end pressure, or of ascertaining its effect, but it was found that other things being equal (apparently) the tighter the bolts were drawn the lower would be the bursting pressure. In a number of instances the pipes burst in trying to get the bulkheads tight, before there was any internal pressure that would register on the ordinary steam gauge used, this referring to plain pipe only.

The reinforcement consists of flat bands of open hearth steel, ranging in section from ⅛ x ⅜ to ¼ x 1¼ inches. The hoops were sheared to length and punched for rivets in a combination punch and shear driven by a 3 h.p. gasoline engine, and rolled to proper circle in a 4½ in. set of rolls driven by the same engine. Two or more rivets were driven in each hoop, spaced 1 in. apart, one behind the other on the centre line of the hoop band. Rivet shear was taken at a maximum of 10,000 lbs. and the section of steel in hoop at rivet hole not to exceed 16,000 lbs. per sq. in.

As the hoops were rivetted they were made up into bundles each containing just the number of hoops required for a two-foot section of pipe. This guarded against the moulders inserting a wrong number in any one section. A quantity of these hoops made up and bundled are shown in Fig. 11.

The longitudinals were made up of the same steel stock, two or four to each section of pipe, proportioned to size and head, with a return bend on each end. The ends of these bars are shown in the pipe illustrated in Figs. 9 and 10. The moulds were provided with clips, which held the longitudinals in place during the moulding, and the longitudinals were placed inside of the hoops and served to hold the latter concentric with the shell. The hoops were spaced by means of gauges and no trouble was experienced in getting them in their proper positions. The standard construction called for three hoops per foot, varied in a few instances. The pipe yard force consisted of about forty men and turned out from 500 to 1,350 feet of pipe a day, depending on the proportions of plain and reinforced pipe made.

Pipe Laying

The trenches were graded so that the drainage of the pipe to frost taps was provided for, the standard practice being to sink the pipe so as to have not less than 18 in. of cover over it to the surface of the ground. This required quite deep cuts in places, through knolls and swells in the surface of the ground. The excavations were well made, straight, and of good finish to bottom. The contractor was not required to lay the pipe to line, either for grade or alignment. This greatly reduced the cost of the installation.

Pipe from 6 in. to 12 in. bore was laid by a gang of two men, 1 mixer and 1 layer; 14 in. and 16 in. pipe was laid by a gang of three men, and larger pipe by gangs of 4 to 6 men. It was not found economical to use tackle for handling pipe up to and including 24 in. which weighed 200 lbs. per foot. The ends of all pipes were cleaned with a stiff wire brush to remove the "laitance" and any adhering earth. They were then wetted and the bevel end "buttered" with neat cement, while the pipe was standing upright. The pipe was then turned down and the bevel shoved over the spigot end of the pipe previously laid, and the joint completed with 1:1 cement mortar, a collar, 3 to 4 inches wide by from ½ to ¾ inches thick being trowelled around the pipe over the joint.

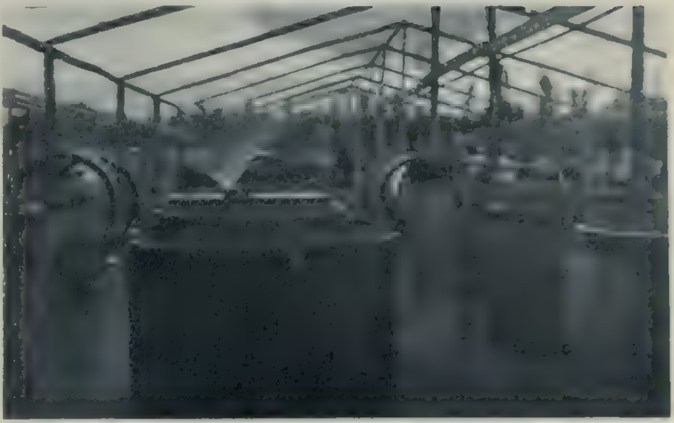


Fig. 9.—30-inch pipes standing on rings.

Two methods of joining the longitudinal bars of the reinforced pipe were used. The first was by means of clips formed of short pieces of band steel of the same thickness as the connecting longitudinal but ¼ in. wider. These clips had a return bend on each end similar to the bends on the longitudinals with which they engaged. The second method was by means of No. 12 steel wire, by wrapping sufficient turns of the wire in the hooked ends of the adjoining longitudinals to make the area of the wire slightly exceed the area of the longitudinals.

Both connections proved adequate, but the wiring was preferred as each turn could be brought taut as put on and the strain placed equally on all longitudinals, while with any form of clip or connection that was made up in advance in the shop there would be a slackness in the connection of some of the longitudinals where the axial directions of the pipe was not perfectly straight, and as noted above, the grade line was undulating. The wiring methods proved a little more expensive than the clips, but it was used for the greater portion of the reinforced pipe. Neat cement "butter" was worked in and around the wiring and the whole connection covered by the collar.

That the longitudinal reinforcement has great

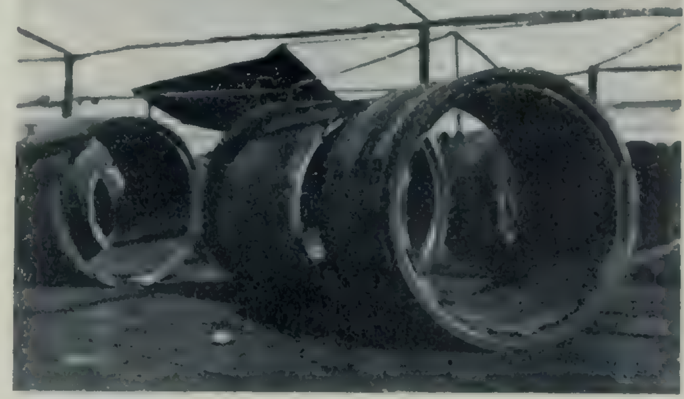


Fig. 10.—30-inch pipes completed.

strength is shown by the following incident. A section of 20 in. pipe, to work under 60 feet head, crossed a piece of swampy ground for a distance of about 70 feet. Efforts were made to get a sufficiently firm foundation for the pipe, but when the line was filled with water a number of leaks were found at this point, assumed to be due to settlement of the pipe. The water was drawn out and efforts were made to close the leaks on the outside of the pipe, but owing to the mud and water of the swamp a satisfactory job could not be done. It was then decided to cut out a section (2 ft.) of the pipe and make the repairs on the inside. This opening was made at a point beyond the swamp, about 7 or 8 feet higher than the lowest point, where the trench was in sand and gravel, this point being chosen for the easy excavation. At night, while the pipe was open, a violent rainstorm occurred, and sufficient surface water ran into the canal to cause a flood of water to come down the pipe line and flow out at this opening. The water then flowed back to the low ground outside of the pipe, washing away the backfill and undermining the end of the pipe for a distance of 10 feet. The longitudinal reinforcement held up this length of pipe and its load of water, the action being that of a cantilever. Examination the next morning showed a crack (extending about one-half the circumference) in the joint over the point of support, and a similar crack about 6 in. back in the pipe from the cracked joint, and the unsupported end had settled down about 0.1 ft. below grade. This end of the pipe was jacked up to grade, the cracks chipped open and pointed with cement, and the intended repairs made through the swamp and the line closed up.

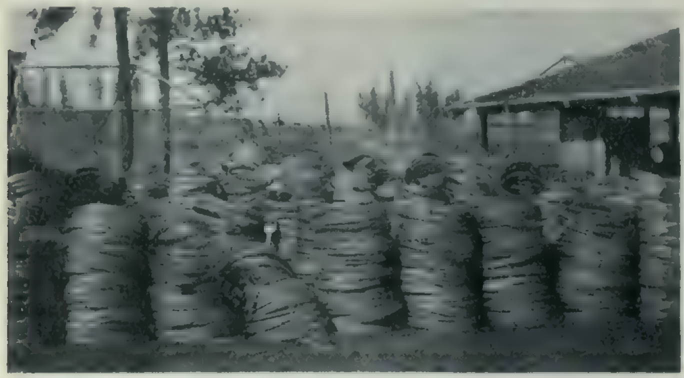


Fig. 11.—Hoops used in reinforcing pipes.

The grade of the pipe where the washout occurred is plus 12 per cent., which would mean a depth of 1.2 feet of water over the point of support when the water just overflowed the open end. As it flowed in sufficient volume to wash away 8 or 10 cu. yds. of earth in less than an hour, there was evidently a good-sized stream running.

When laying pipe of 20 in. bore and larger, the joint was pointed and smoothed on the inside. For smaller sizes a bag filled with hay was drawn through, keeping the bag three or four joints behind the layers. The appearance of a completed line is shown in Fig. 13, which also shows a standpipe in the distance. In some cases the pipe lines were covered 3 or 4 inches deep with backfill as soon as laid; in others they were left entirely open until after testing, in which case the top of the collar was covered with a few trowels full of sand, as shown in Fig. 13.

Whether the pipes are covered immediately depends, of course, on the kind of weather and the length of time that will probably elapse before the testing. If left exposed to alternate sunshine and cold nights the pipe will crack circumferentially at intervals, but a collar can be put around these breaks just before testing with very little labor, and the advantage in having the pipe entirely exposed for inspection during the testing more than pays for the extra trouble.

Expansion Joints

These were inserted where the pipe lines entered distribution boxes, stand pipes, and where branch connections were made, but the type of expansion joint adopted proved to be of little value, and under the pressures used gave trouble by blowing out and leaking. The joint consisted of a reinforced concrete sleeve from 8 to 12 inches long, according to the size of pipe, cemented to one section of pipe and surrounding the other, leaving an annular space of from ½ to ¾-inch, this space being run full of melted asphalt. The outside end of the annular space was reduced to from 1-16 to ⅛-inch so as to prevent the asphalt squeezing out with the pressure of the water. After the lines had been in use for a time it was observed that the asphalt was being forced out, and once the water got through the asphalt would be cut away in no time. After a good deal of experimenting the best solution of the trouble was found to be to run a fillet of cement mortar around the end of the sleeve, practically making it a rigid joint, but weaker than the adjoining pipe, so that it would "give" first if expansion or contraction required movement at the expansion joint. As a matter of fact the writer never detected any movement at any of the expansion joints, either before or after they were cemented fast; and, in his opinion, expansion joints in a buried cement pipe line are of no use whatever.

The co-efficient of friction between even very smooth concrete pipe and earth is high, and when one considers the weight of the pipe, the contained water and the varying weight of backfill on the pipe, by any reasonable assumptions one may make, the amount of longitudinal reinforcement that would cause pipe to "creep" between expansion joints, even if only 100 feet apart, would be enormous. While it might be possible to build such pipe it would be quite another matter to find a customer who would be willing to pay for it.

Even in the interior of British Columbia, which has rather extreme ranges of temperature, the variation in the shell of pipe buried from 18 in. to 2 ft. below the surface is not likely to be more than 10 deg. to 12 deg., or say a variation in length of 0.055 ft. in 1,000 feet. With a modulus of elasticity of 2,000,000 in concrete, a 10 deg. variation would equal a stress of 9¼ lbs. per sq. in., either to stretch or compress the concrete sufficiently to compensate for change in temperature, but as concrete cannot be made perfectly homogeneous the strain would probably accumulate at weaker points and start cracks, circumferential cracks if in tension and longitudinal or diagonal cracks if in compression. Therefore it seems wise to provide longitudinal steel to distribute these strains as equally as possible. At 9,250 lbs. stress in the steel, 0.1 per cent. of steel would be required, and to the above stress in steel add that due to stretching or compressing the steel itself, which would be $30{,}000{,}000 \times .0000055 \times 10 = 1650$ lbs., or a total unit stress of 10,900 lbs.; or say that for each degree variation in temperature 0.01 per cent. of steel is required. This is the writer's theory of longitudinal reinforcement and he does not remember of having seen such analysis offered before.

Additional reinforcement may be required to take outward thrust on sharp curves, when the pressure would have to be considered.

"Swelling" in Concrete Pipes

A much more serious matter than changes of length due to temperature is the expansion in length that takes place when a newly laid, dry concrete pipe is filled with water and the expansion due to saturation takes place. The amount of this expansion is indeterminate as the degree of "dryness" of the pipe as laid may be anything from perfectly dry to perfectly wet, depending on the weather and the time that the pipe has laid in the sun and wind along the ditch. If a line of plain pipes is laid in a dry condition a dangerous compressive strain may be brought on them when they become saturated. A rupture from this cause will show about the same characteristics as a rupture from internal pressure, where there is any pressure at all internally. Where there is no internal pressure (as in a gravity flow line) the end compression will manifest itself by splitting the pipe lengthwise, or nearly so, in one or more places, generally two, and the two parts of the pipe will spring apart in bow-shaped segments, thereby shortening and giving relief to the strain. A crack so started will continue to run, just as a crack will run in plate glass, and unless discovered a lot of pipe may be lost. The failure of unreinforced pipe from this cause is very similar to the failure of un-hooped concrete columns. Like the columns, the remedy is to use hoops in the pipe; in other words, plain pipe has no place in important installations.

Fig. 12.—Pipe line construction.

A very little steel seems to be sufficient, but we have no exact figures as to how little. The lightest reinforcement used on the work described herein was 1 hoop, 1/8 x 3/8 in. per foot in 12-in. pipe. Out of some thousand pieces of reinforced pipe laid none ever developed any crack or flaw that could be detected.

In the plain pipe there were eight ruptures that were believed to be the result of end compression and about the same number that were attributed to internal pressure only but may have been the result of compression, as the breaks did not occur where the head was particularly high. It was also found advisable to relay about 400 feet of plain 14-in. pipe working under a head of 24 to 28 feet with the same size of pipe reinforced with one 1/8 x 1/2 hoop per foot. There was a good deal of surging and air hammer in this section that caused a number of blow-outs and warned us that there was not sufficient margin of safety.

The writer is of the opinion that if the money usually devoted to expansion joints and excess longitudinal steel in reinforced pipe were devoted to lightly hooping all the otherwise plain pipe, a much better balanced construction would result without appreciably increasing the cost of the installation.

It may be said of the "swelling" that once the pipe becomes saturated the pores begin to close and the pipe to dry up (on the outside at least) and very likely there is a gradual decrease from the maximum compression; in any even the writer's experience has been that no further compression ruptures occur after the line has been in use for a month or so, and even if emptied for a long time there will be very little swelling when again filled (referring of course to pipes below ground).

Testing and Permeability

When first filling the system the water was allowed to enter slowly so that the swelling might take place in advance of much pressure. The pipes were afterwards emptied and filled a number of times and no further precautions were taken, the water being admitted as rapidly as the supply permitted, to save time. As stated elsewhere there were no failures or faults developed in reinforced pipe, but there was some trouble with plain pipes, as noted. The test consisted in running the pipes at full capacity under as near working conditions as possible.

The opinion is prevalent that dry-rammed pipes are more permeable than pipes cast of wet mixtures, but our experience is to the contrary with machine-rammed pipe. The dry-rammed pipe is not quite as strong as the other, however. If the pipes become thoroughly dried out before the water is admitted they will be quite permeable at first, but gradually take up and in from a few hours to a day or two the leakage through the pipe will stop. The percolation through the cement mortar joints will continue much longer, however,—perhaps for a month or more,—but these, too, will eventually dry off. Coating the pipe inside with a brush coat of cement grout soon after they are moulded will greatly reduce the amount of percolation at first, but the final result seems to be the same, whether they are coated or not.

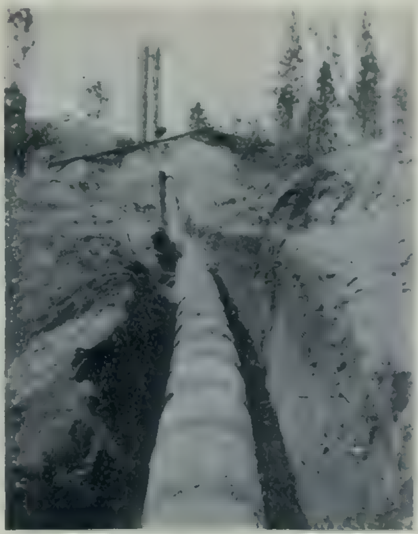


Fig. 13.—Completed pipe line before back-filling trench—Standpipe in background.

After the above lateral No. 5 had been filled for a few weeks it was very hard to tell, in most places, from an outside view of the pipes whether the water was in them or not, and this under heads up to 140 ft.

Thickness of shell does not seem important as long as the steel is properly protected and the pipe is strong enough to carry backfill. Some pipe was made without the addition of hydrated lime and this was no more permeable than that with lime. The writer sees no advantage in using lime or other waterproofing and thinks the money thereby saved would be better spent for additional care and time spent in moulding and curing.

Capacity of Pipes

The distribution system was planned for a delivery of 0.06 sec. ft. for 5 periods of four days each during the irrigation season, which gives an aggregate delivery of 2.45 acre feet per acre per season.

The discharge of pipes was figured by Kutter's formula, using $n = .013$. For pipes large enough that the joints may be trowelled inside, this friction co-efficient is too high, and we think .011 to .012 would give truer results if air is kept out. For small pipes, however, the stated factor is none too high. It does not pay to make less than 2-in. variations in diameter and it seldom happens that the calculated diameter just falls on a standard size of pipe, so that great refinement in calculating small diameters does not seem necessary. In fact it is not worth while to figure capacities at all unless comprehensive and sufficient measures are taken to exclude air from the pipes, as comparatively little air may reduce the capacity of a pipe 25 to 50 per cent. or more if the velocity is high, and to properly exclude the air seems to require more experience and higher engineering skill than any other single feature of a pipe installation. Irrigation distributing lines are quite different from power or waterworks pipe lines, inasmuch as the former usually have but one place where air will be admitted at the intake, while irrigation lines must have comparatively large openings at rather short intervals, which will discharge water or take in air impartially unless carefully designed. The writer has seen some that would perform both functions simultaneously. No matter how carefully planned, some air will gain admittance and will cause surges that will raise the static head 10 or 15 feet or more and should be allowed for in figuring strength of pipe.

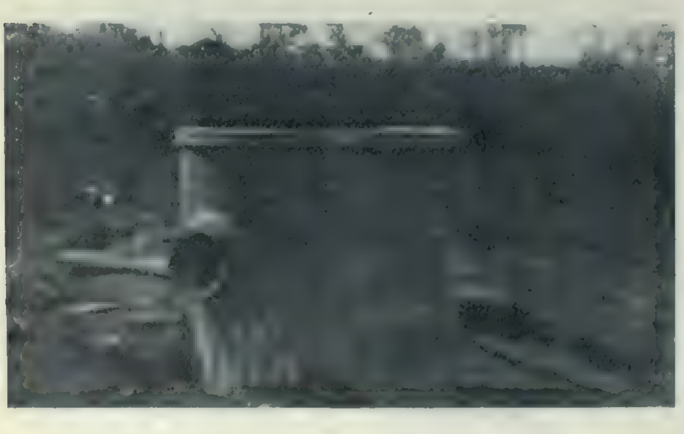


Fig. 14.—Distribution box used on pipe line.

Distribution Boxes

Delivery of water from the mains is made through concrete distribution boxes, one type of which is shown in Fig. 14. These boxes have an interior partition, with an opening near the bottom, closed by a slide gate. When this gate is open the water flows directly through and re-enters the main below the box.

When the gate is closed the water rises in the box and overflows a weir in the top of the partition. In another partition plate is an orifice 4-in. high by 12 to 24 in. long, with sliding shutters by means of which the length of orifice may be reduced.

The centre of this orifice is exactly 4 in. below the lip of the overflow weir in main partition. The Water Bailiff is provided with a table showing the discharge through the orifice for each inch (or fraction thereof) of length, and the sliding shutters are set to deliver the desired quantity, then the bottom slide gate is closed until the water rises and just nicely overflows the waste weir.

Concrete in Irrigation Work in the Okanagan Valley.

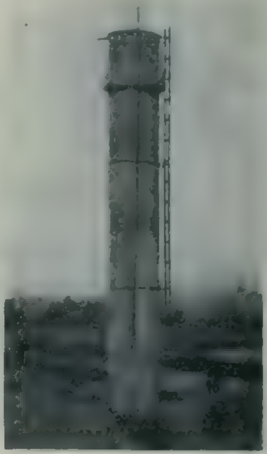


Fig. 15. Standpipe for controlling hydraulic grade.

This maintains the standard depth of 4 in. to centre of orifice and makes some allowance for fluctuations in the main. The water passing over the waste weir falls to the bottom of the box and re-enters the main below the box. The water passing the orifice falls into a trough and is led through the side of the box above the ground level. The arrangement is such that the position of the shutters or slide gate can not be altered from the outside of the box. The entire construction, except iron slide gate and wooden door over man-way in cover, is concrete. The door is secured with a padlock.

Standpipes were erected in several places to control the hydraulic grade line where it happened that the summit on the main pipe was lower than the ground to be irrigated. One of these is shown in Fig. 15. It is built up of 30-in. reinforced pipe, surrounding a 20-in. interior riser through which the water rises and returns in the annular space between the two pipes. A by-pass is provided so that the water may be sent directly through if desired. These standpipes acted to a certain extent as surge tanks.

In conclusion, in justice to the other irrigation companies in the Kelowna district, it must be said that the standard set by the South Kelowna Company is approached by several others. Of the four larger systems in the district the Central Okanagan Company have all or practically all their ditches lined with concrete, and steel and wood pipe distribution, and the Belgo-Canadian Company and Kelowna Land and Orchard Company have partly lined canals and are extending the lining yearly, and are using concrete pipe extensively. No first-class company now considers the use of wood flumes or earth ditches, and the standard of construction is constantly rising.

Application of Brick in Engineering Construction[*]

By E. E. R. Tratman[†]

THE use of brick in engineering work is extensive and varied. In recent years its use has become considerably restricted in some lines of construction, while some new lines have become important.

Brick for Sewer Construction

The sewer systems of cities afford one of the largest fields for the use of brick. Much of the work is of an ordinary character, but there are many cases in which size, form, special design, methods of construction, or difficulties encountered, make the work of interest to the engineer. At Detroit, most of the sewers are of brick. The largest brick sewer planned and built during 1913 was the Morrell St. sewer, about five miles long, from 8 to 9 ft. diameter, and costing $685,000. A similar trunk sewer now under construction is the Mt. Elliott Avenue sewer, a considerable portion of which is 9 ft. diameter, built in tunnel.

At Cincinnati there are about 80 miles of brick trunk sewers. Brick is used for all sewers over 2 ft. diameter, and the largest brick sewer is about 20 ft. diameter. The larger sizes (and the smaller ones where necessary) are backed up with haunch walls of rubble masonry or concrete. Vitrified-brick lining is used in the inverts of concrete sewers (up to the springing line) but only where the velocity of flow is excessive; that is, over 8 ft. per sec. In some cities, however, all concrete sewers are lined with brick (at least in the invert), while others do not use brick in any of their concrete sewers.

At St. Louis, brick is used for all sewers over 27 in. diameter and up to 9 ft. diameter, and is used for still larger sizes in special cases. During 1913 there was under construction the Rocky Branch joint district sewer, 10 and 14 ft. diameter, brick being used because the congested condition of the streets made the establishment of a concrete plant a difficult matter. There was also the Glaise Creek joint district sewer, a trunk sewer of 10 ft. down to 8 ft. diameter, brick being used entirely because the amount over 9 ft. diameter was too small to warrant installing a concrete plant. Vitrified-brick lining is used in the invert of concrete sewers.

At Philadelphia, brick is used in egg-shaped sewers 2 ft. 3 in. by 1 ft. 6 in. to 4 ft. 6 in. by 3 ft. and in circular sewers from 2 ft. to 20 ft. diameter. Concrete is used only for sewers up to 5 ft. diameter except in special cases, and has brick lining in the invert only.

In Chicago there are about 1,958 miles of sewers, of which all but 14½ miles are of brick, with a diameter of 3 ft. to 10½ ft. The largest concrete sewer is of elliptical section 14 ft. high and 12 ft. wide. No brick lining is used in any of the concrete sewers in Chicago or Kansas City.

At Cleveland, all but about 6 per cent. of the large sewers are of brick, the smallest size being egg-shaped in section, 24 in. wide and 27 in. high, and the largest being 16 ft. diameter. Concrete is used to a considerable extent for the foundations of sewers, and in several cases there has been used a combination of brick lining for the entire inner ring, backed with concrete.

At Minneapolis, brick is used only for the manholes and catchbasins. At Kansas City, no brick sewers have been built for three years. For sewers over 30 in. diameter, bids are asked on brick, reinforced monolithic concrete, and reinforced-concrete pipe. The awards are made to the lowest price material, which is generally monolithic concrete, but in some cases concrete pipe. The concrete sewers are not lined with brick. A special development is the use of hollow segmental blocks, and, owing to their size and light weight, the work can be done much more rapidly than with brick.. These blocks have been used in sewers from 27 in to 6 ft. diameter, and are made for sizes up to 9 ft. diameter.

Brick Tunnel Lining

At Chicago, brick has been used in certain parts of the Chicago Avenue and Wilson Avenue tunnels of the water-works system; in all about ½ mile of tunnel, 8 ft. diameter. The water-intake tunnels at Cleveland have a brick lining, and brick is to be used also in the new intake tunnel at Milwaukee. At Cleveland, a long intercepting sewer has been built parallel to the short line, and nearly five miles of this are in tunnel with a four-ring brick lining, having an interior diameter of 13½ ft. and 12¼ ft. This was driven in stiff clay soil, by means of a steel shield. The bricks were laid in Portland cement mortar, and though the jacks pressed against the end of the completed lining, the only damage done was at the points of application of the jacks, and this small amount of masonry was repaired each day as the shield advanced.

The lining of railway tunnels was at one time a field for brick, but this is now much less extensive. An example of modern work is the double-track Elm tunnel on the Frankfort & Berlin Railway in Germany. This is 2¼ miles long, and was built under considerable difficulties, owing to the pressure or "squeeze" of the ground. The celebrated Thames tunnel was built of brick, as were the large double-track arched tunnels of the original underground railways at London. These were near the surface, but the present "tube" lines are single-track deep-level tubes with cast-iron lining. With the advent of the modern subway and underground railway there has been opened a rather large field for the architectural or decorative use of brick in the facing of the tunnel lining at the stations, and, though this is mainly for glazed and ornamental brick, it indicates how new fields open, although old fields for the use of brick may become closed or restricted.

Chimneys

Most important brick chimneys now built of special radial hollow brick. The monster brick chimney for the Boston & Montana Copper Company, at Great Falls, Mont., is 506 ft. high and 50 ft. diameter at the top, the proportions being very unusual. It is built on the Custodis system, and is said to be both the tallest and largest chimney in the world. Next to it comes a Heinecke brick chimney 460 ft. high, but with a diameter of only 8 ft. at the top. This chimney carries the acid gases from smelters and is reported to show no deterioration after 20 years' service.

---

[*] Abstract of a paper presented at the annual convention of the National Brick Manufacturers' Association, New Orleans, Mar. 2-7, 1914.

[†] Resident Editor "Engineering News," Chicago.

Another exceptional brick chimney, which is large in diameter as well as in height, is that of the St. Joseph Lead Company, at Herculaneum, Mo. This is 350 ft. high and 20 ft. diameter at the top. It has an octagonal base 40 ft. high and a circular shaft 310 ft. high. The base contains two openings and is built of vitrified paving brick, laid in English bond. The shaft is built of the Heine perforated interlocking radial brick, and the walls are laid up with alternate header and stretcher courses. The chimney is reinforced by steel bands 4 x ½ in., embedded in the brickwork, and spaced about 20 ft. apart for the entire height. Only the lower part of the interior is protected by a lining (40 ft. high), owing to the relatively low temperatures of the entering gases. Both the paving brick and the radial brick were hard-burned shale brick, having a compressive strength of over 5,000 lb. per sq. in. and with a very low absorption. They were tested for their acid-resisting qualities by immersion in 25 per cent. sulphuric-acid solution for 48 hr. and afterward by boiling this solution continuously for 30 min. without removing the sample from the solution. No effects of the acid on the brick were noted.

The chimney was built to carry off the products of combustion and the fumes of a lead-smelter plant. The gases have a temperature of about 200 deg. F. and contain a high percentage of sulphur, making it necessary to build the chimney of acid-proof materials. The bricks are laid in lime-cement mortar, on account of its strength, but as this mortar is decomposed in time under the influence of the acid in the gases, all the mortar joints liable to be attacked by the contact of the gases were made acid-proof. The interior joints for the entire height of the chimney and the exterior joints for 100 ft. down from the top were raked out to a depth of 1½ in. and pointed up with a mortar made of raw benezet. The entire lining was laid with this mortar. The material is a very high grade of fire-clay and is acid-proof; it contains about 36 per cent. alumina and 49 per cent. silica. with only a trace of lime, magnesia and iron oxide. The top of the chimney is covered with a heavy lead cap, extending 12 in. on the inside and outside, and for 100 ft. from the top the iron ladder rungs are covered with ⅛-in. of lead.

Quite recently a brick chimney has been built at a blast-furnace plant, serving the hot-blast stoves, which is said to be the first used for this particular purpose. At industrial plants there has been a tendency to use steel chimneys serving one or two boilers each. due to a certain prejudice against a single large central brick stack, but there is a much greater loss of heat through the steel stack, due to radiation and convection, unless there is the additional expense of a brick lining.

Brick for Paving

The use of brick for paving is a matter of great engineering importance, and in the past 15 or 20 years the manufacture of paving brick has developed into a special industry. Engineering, experimental and research or laboratory work, has assisted largely in this development, in various ways: 1, the investigation of clays and their properties; 2. the manufacture of the brick. so as to secure a tough. hard and uniform product; 3, the testing of the finished product; and 4, the proper methods of constructing the pavement. For many years, brick paving was confined mainly to the streets of towns and cities but it is now being applied extensively to the paving of country highways.

At one time brick was extensively used for bridges and large arches, but this use has become practically obsolete in this country and is on the decline in other countries. However, in some arch bridges of concrete construction brick is used as a facing, in order to produce an effective appearance and to form a durable surface finish. This has been done more extensively abroad, but one example in this country is the Sixth Avenue bridge in Des Moines, Iowa, which has a series of arches, with red-brick facing on the arches and piers.

Another use of brick which is more common abroad than in this country is the facing of the walls of docks and piers. Concrete forms the mass of the wall, but this material is often liable to disintegration, particularly at the water line. It is also difficult to repair when worn or when the surface is broken by heavy blows or chafing. The brick used for this facing, in foreign work, are usually of a special character, much larger than ordinary brick, extremely hard, and frequently dark blue in color. At points on the Nova Scotia coast walls have been faced with vitrified brick.

Present-Day Practice in Concrete Road Construction

GREAT care is requisite in order to obtain good results in concrete pavements. In discussing the value of such pavements, there is, of course, some question as to the kind and amount of traffic they will stand. In Massachusetts, in 1906, a concrete surface was laid on a section of State highway in the town of Spencer, and stood the traffic remarkably well. The principal objection was that it was rather hard for the feet of the country-bred horses, which, if allowed to select the traveled way, turn out on the earth shoulders. A bituminous surface remedied this condition, and at present the road is giving excellent service. The section mentioned was put down by the grouting method, known as the Hassam process. On investigation it was found that the grout had penetrated, not only 6 in. of broken stone, but an additional 2 in. of gravel sub-surface. Very little trouble was experienced from disintegration of the concrete surface; it was confined principally to the area adjacent to the expansion joints.

Since that time some roads have been built by mixing the concrete before placing. Care had to be taken to have the batch properly tempered, particularly in building on a grade. If too wet, the mortar had a tendency to creep and form waves on the surface, and, of course, a dry mixture was not readily flushed, hence it was difficult to get a good smooth surface. The concrete was placed in a single layer, and as near a mosaic surface as possible was decided, in order to permit the bituminous material to bond properly. To obtain that result, various methods were tried. After placing the concrete, dry stone was spread over it, and tamped lightly. This worked well, but required considerable skill on the part of the men who were spreading the broken stone. The experiment of allowing the concrete to set twenty-four hours, and then brushing it off with a steel broom, gave, perhaps, the most satisfactory results.

Mixture Too Lean

There is a tendency to use too lean a mixture for concrete road surfaces. Many engineers have advocated a 1:3:6 mixture, but that is not rich enough, for concrete exposed to the traction of wheels and blows from horses' hoofs must be very tough to resist abrasion. Added strength cannot be gained by reducing the percentage of stone aggregate, that is, assuming 2 parts of sand to be the correct quantity to be used with 1 part of cement. Such a mortar will fill the voids in 4 parts of stone, and no added strength is gained by reducing the stone aggregate to three parts. Too small a proportion of stone means a large percentage of mortar, thus giving a smooth surface, which would be slippery and not desirable.

The concrete pavement has the advantage of being not only a surface, but also a foundation. Though, of course, there may be conditions where some treatment of the sub-surface will be needed, with a uniform soil, in which the frost action is about the same in all parts, there is very little difficulty. If, however, the soil is varied, so that the frost will affect one portion of the road more than another, the concrete will crack. It is an unusual condition where such cracks are serious enough to disintegrate the concrete, and any ordinary cracking is not material. This is particularly true where concrete is coated with a bituminous material, as the cracks are then sealed over and give no trouble. With concrete, as with all other smooth paving, the surface is rather slippery, necessitating care in designing the maximum grades and the camber of the road.

A light bituminous top on a cement-concrete base solves many road problems. It is reported that there is much difficulty in making the bituminous material stick to the concrete. In Massachusetts success has been obtained by the following method: The concrete surface is swept as clean as possible, then sprinkled with water, and while still wet covered with Tarvia A, heated to 200 deg. Fahr. and applied at a pressure of not less than 70 lbs. per sq. in., and at the rate of one-quarter gallon per square yard of surface. This is then covered with clean stone screenings (not exceeding ½ in. in diameter and from which the flour has been removed) spread at the rate of 0.015 tons per square yard of surface. This is again watered and while still wet a second ¼-gal. coating of tar is applied in the same manner as before, but covered with clean, gravelly sand, using 0.015 cu. yd. per sq. yd. of surface.

I am aware that the application of tar on a wet surface is contrary to existing theories, but it has worked satisfactorily. This road, treated in August, 1910, has cost to date, $15 for total repairs on more than 4,000 lin. ft. of 15-ft. surface and it has taken only 30 gal. of tar to replace such small places as have scaled off. I believe that the successful adhesion of the tar to the concrete is due to the wet surface of the latter and the high pressure used in spraying the tar on the road.

Recommendations for Concrete Road Building

Principles Advocated by the National Conference on Concrete Road Building

FUNDAMENTAL principles of concrete-road construction were adopted at the National Conference on Concrete-Road Building, held in Chicago last month. The salient features of the recommended practice are:

1. The aggregate should be clean and hard.
2. The sand should be coarse and well graded.
3. A rich mixture should be used.
4. The materials should be correctly proportioned.
5. The materials should be thoroughly mixed.
6. The inspection should be intelligent and thorough.
7. When in doubt, reinforce the pavement.
8. The subgrade should be of uniform density, thoroughly compacted and drenched with water immediately before placing concrete.
9. The concrete should be of a viscous, plastic consistency.
10. After placing, the concrete should be immediately covered and kept moist and not opened to traffic for four weeks.

Additional Suggestions

For all roadways less than 20 ft. in width is recommended a cross-section showing a slab thicker in the middle than on the edge, built upon a flat subgrade. The dished subgrade recommended in the report of the committee on contraction and expansion is not mentioned.

Minimum widths of 10 ft. for single-track and 18 ft. for double-track roads are approved. In the country a crown of 1/100 of the width is recommended; for city pavements the specified crown is 1/70.

The use of suitable reinforcing at the junction of shoulders and metal, as stiff gravel or stone chips, is urged.

Joints should be avoided, if possible. Reinforcing the slab is the alternative suggested. In fact, it is urged that all roads exceeding 20 ft. in width be reinforced with wire fabric whose co-ordinate cross-sectional areas are 0.038 sq. in. and 0.049 sq. in. per foot, the greater section to be applied transversely. The type of filler recommended, if joints are necessary, is that made of two 3 x 3-16-in. strips of metal separated by about ¼ in. of prepared felt.

Adding materials or water to mortar or concrete that has partly hardened and carrying on work during freezing weather are practices strongly condemned. If the temperature should drop below 35 deg. Fahr., the water and aggregates should be heated and the work protected from freezing for at least ten days. Concrete should not be deposited upon subgrade that is frozen.

Cement is handled in bulk for the construction of the new plant of the Baldwin Locomotive Works at East Chicago, Ind. The foundations involved more than 10,000 cubic yards of concrete, and cement in bulk was brought to the contractors' attention as a means of making a considerable saving. Cars are spotted alongside the mixer bin and both sand and gravel are delivered directly to the bins by a clamshell bucket. Bulk cement, however, required a system of elevator buckets on an endless chain and a modified grain shovel, operated by power and guided by a laborer, is placed in the car and manipulated in a manner similar to that of a grain-hauling shovel or a scraper.

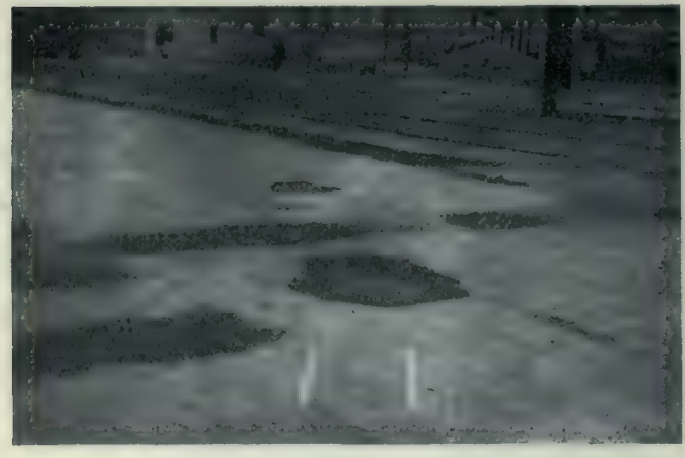
Relative Economy of Constructing Bituminous Concrete Pavements and Bituminous Pavements by Penetration Methods*

By Geo. C. Warren†

KEEPING constantly in mind a broad view of the term "economy," the writer proposes to discuss only: (a) true "Bituminous Concrete" and (b) "Bituminous Macadam" defined by the American Society of Municipal Improvements, as follows:

"Bituminous Pavement Definitions"

"**Bituminous Concrete** is a pavement consisting of a combination of broken stone and sand, or fine mineral matter, cemented together with a bituminous cement, and which has all its ingredients mechanically mixed before being laid. To be termed a bituminous concrete it must partake of the well-known characteristics of concrete, that is, there must be stone enough in its composition to form an important part thereof and add to its strength and durability; also there must be enough of the mortar constituent, that is, the sand and bituminous cement, to properly support and bond together the largest particles. It is normally a one-layer pavement, all parts of it having equal stability, due both to the structure of stone and the bond of the bituminous cement, and depending on the base for vertical support only. It may or may not be finished with a skim coat and top dressing of sand or stone chips. It is adapted to be laid on either a concrete or macadam base which may or may not have a light coat of bitumen to increase the adhesion."



Road laid with asphalt cement by the penetration method—after four years' use. Note general wavy condition and ravelled section.

Bituminous concrete pavement laid in 1905. In excellent condition after eight years' use.

"In the paving mixture, gravel may wholly or in part be substituted for crushed stone, and fine crushed stone for sand. Mineral dust also may be added to increase the density and stability of the mixture."

"**Bituminous Macadam** is a pavement consisting principally of crushed stone, retains its integrity of structure mainly by the mutual suport of the various particles of stone, aided by the slight bonding value of the fine mineral matter in its composition, and protected from surface disturbances by an upper bonding layer of bituminous material. It is a one-layer pavement and there is no definite distinction to be made between the wearing surface and the base, as in their nature they must be knit together in one structure. Practically all the horizontal stability as well as vertical support is from the macadam base."

As it is manifestly impossible to express a true comparison of the economy of these two types of construction in dollars and cents, the writer will endeavour to show the relative satisfaction which has been given the public by several instances where both types have been in use on the same street for several years.

In a paper prepared by the writer for the International Road Congress held in Brussels in July, 1910, on the subject of "Bituminous Roads—Mixed and Poured" he referred to a then recently constructed "Bituminous Macadam Penetration Method" road then one year old and constructed with most careful consideration of the details and most approved methods of construction on Huntington Avenue, Boston, one section using bituminous cement prepared from coal tar and the other from asphalt.

A series of eighteen photographs accompanied that paper, showing, that notwithstanding the unusual care practised in the construction, the unequal distribution of the bitumen was such that the surface of the road was badly marked, rutted, and shoved, in many places having a surplus of bituminous material, and in many other places pitted and ravelling where insufficient bitumen was distributed, or where it had penetrated insufficiently into the voids between the particles of stone.

Now, after four years' use and very considerable repairs each year the bituminous material on the section laid with bituminous cement prepared from coal tar has practically all disappeared, and the macadam, which is also badly worn, is carrying the traffic. In small portions of the surface, where a surplus of bituminous material was used, it is still in evidence.

The section in which asphalt cement was used, is, after four years' use, in better condition than the coal tar cement section referred to above, because, in the asphalt section the asphalt for the most part is still in evidence, but the road surface is in a most deplorably unsatisfactory condition, as may be seen in Fig. 1.

---

* Extract of paper presented before Section D of the American Association for the Advancement of Science.

† President Warren Brothers Company, Boston, Mass.

On the same side of Huntington Avenue, but two miles nearer the centre of the city, and consequently carrying more than double the volume of traffic than the "Penetration Method" construction above referred to, is a "Bituminous Concrete Mixed Method" pavement laid in 1905, which has stood the traffic of eight years and is illustrated in Fig. 2.

The relative economy of these two stretches of pavement is about as follows:

1st. Length of time street was closed to traffic during initial construction, about equal for the two types.

2nd. General appearance of street surface at time construction was completed, about equal.

3rd. General appearance during the first warm weather in the spring following construction: Bituminous concrete presented uniform, hard, gritty surface, affording easy traction, and good footing for horses.

Penetration method, where insufficient amount of butimen had been used, was already ravelling in spots, but where excess of bitumen had been used, surface was badly shoved in spots, and bleeding to such an extent that the area which had been laid with asphalt cement was given a coat of crushed screenings, which soon ground up and made the street exceedingly dusty for some weeks, and also made traction so heavy during warm weather, that horses approaching this stretch at a trot would break into a walk before traversing one-half its length.

4th. Interruption to traffic while making repairs: Bituminous concrete, has stood for eight years without any such interruption.

Penetration method, has during the four years of its life, been repaired in spots many times, with traffic naturally impeded, even though not entirely blocked by the repair gang.

5th. Initial cost of the stretch laid by the penetration method is not known by the writer, but was probably about two-thirds that of the bituminous concrete.

Summarizing the above shows that these two types of construction have given the city service as follows.

Bituminous concrete: a wearing surface perfectly satisfactory for all classes of traffic for eight years. The volume of traffic being moderately heavy at times of construction, and steadily increasing since that time.

Penetration method: gave satisfactory wearing surface during the few winter months immediately succeeding its construction, but has never been satisfactory since that time.

This construction was cheap in first cost, but its present condition well illustrates the fact which should be axiomatic, but is not generally so regarded, that first cost is but one and that a small factor in the question of economy.

True "economy" in road or pavement construction cannot be measured by dollars and cents of cost, however frequently the effort may be made to so measure it. Consequently in considering the subject the writer is not making any effort to discuss "economy" from that point of view. The real measures of economy are, general suitability for the purpose intended, durability, utility, wear and tear on vehicles, sanitation, cleanliness, sightliness, and last and least of all, first cost. These are matters which must or should receive careful consideration in each particular case.

Doubtless there are some places where the traffic is so exceedingly light that the penetration method will produce a surface which will answer all practical purposes, and in such cases the less cost of this type would naturally make it the more economical in the broad sense in which the writer has endeavoured to view the subject. However it is the writer's firm belief that such cases are exceedingly rare, and that in judging any one particular case, it is exceedingly dangerous policy to assume that this type of construction will give any better satisfaction to the general public than the cases cited in this paper; and when forming such a judgment, it must be remembered that the traffic on all streets and roads is increasing by leaps and bounds, and at far greater rate than it increased in former years, therefore the tendency is always to underestimate the amount of traffic a street or road will be called upon to resist.

In conclusion, we must not be unmindful of the fact that in the construction of any type of roadway surface, full consideration must be given to careful, scientific, accurate details of construction and to the further fact that "the best is none too good" applies with special force to road construction.

Portable vs. Stationary Asphalt Plants

Experience with One Plant of each Kind in Winnipeg—Reasons Why the Writer Prefers Portable Plant

By J.W. Astley, C.E.*

THE writer, as the city's engineer of construction, is required to bid against all classes of contractors and, consequently, sees things from a contractor's point of view, viz., what are the quickest, cheapest, and most reliable methods? When he was appointed engineer of construction of Winnipeg in 1907, he had to adapt himself to circumstances as he found them. The city at that time had a stationary plant capable of handling 2,000 square yards per day of finished sheet asphalt pavement, 1½-inch binder and 2-inch surface. At the present time, by the use of labor-saving appliances, the same plant can handle 3,000 square yards of the same class of pavement per day, with 30 less men per day at the plant.

This plant was so situated, however, that the only materials that could be delivered to it by rail were asphalt, flux and sand. All other raw material had to be teamed 1½ miles from a supply yard. The purchase of another, a one-car Cummer plant, was recommended in 1910 and has been in use ever since. In this plant the material is dumped from an overhead railway right above the plant, and the saving in hauling and handling material amounts to a trifle over 3 cents per square yard on binder, this being shown by the actual records for four years; and a saving of 4 cents per square yard is made when handling asphaltic concrete, which is laid 2 inches thick on a concrete base. The old plant is used on surface, also for streets in the immediate vicinity, and a saving of from one cent to 2 cents per square yard is made. This saving on the surface is effected by a small reduction in the amount of fuel for melting and in labor.

The question of cost of long haul in delivering material to the street is not so important here as in many cities, because we use a truck carrying 5 cubic yards of asphalt and hauling a trailer with another 5 cubic yards. This truck, which was made by our own mechanics, makes 12 miles per hour empty and 8 miles loaded. Three gasoline tractors also are used, each of which handles a train of five 2½-cubic yard asphalt wagons. These make 3½ miles per hour loaded and 6 miles empty. In another respect our plants are different from the majority, being operated by electricity, the only fuel used being for melting, heating sand, stone, etc., the melting all being done by direct heat with mechanical agitators.

---

* Engineer of Construction for the city of Winnipeg.

In operating our plant no uncoupling of the strings of wagons is necessary, as they are drawn under the hopper by a cable operated by the regular engineer. The asphalt is hoisted and swung into the melting kettle by a small swinging derrick operated by the same man, and the hopper is handled by the same means.

The one-car plant which we have in use we always count on, from actual practice, for 3,000 square yards of 1½-inch binder a day and from 1,800 to 2,000 square yards of 2-inch surface

The stationary plant was the first stationary municipal plant in Canada and, it is believed, the first on this continent, and, consequently, was not built as we would do it at the present time; steel and concrete would be used in place of wood. The maintenance costs are, therefore, greater than they would otherwise be, so a comparison in this respect would not be fair. The yearly maintenance cost for the one-car plant is very small, as, outside of a few new sprocket chains, small repairs to fire brick and to a dust collector, nothing has got out of order, and $300 per year so far has covered all our expenses for repairs.

The question of our future has alreadv been taken in hand, by the purchase and outfitting of supply yards with elevated railway tracks. After possiblv another year, the one-car plant will be moved to one of these yards and do all the work within a reasonable haul, and then move to the next yard direct. The stationary plant will then be done away with, and when the amount of work warrants it the purchase of a second one-car Cummer plant will certainly be recommended by the writer.

From my point of view I would prefer to purchase a one-car plant for use in any town of, say, 60,000 people in place of building a stationary plant; for even if it is left stationary for some years it will be found to occupy less room, cost less to keep in repair, and will do as much work as a stationary plant costing the same money. For larger cities that have enough work for two or more plants I would again recommend one-car plants, and more especiallv if the city has numerous railway lines, making it possible to move the plants near to the work in any district.

The main question from a contractor's point of view (and it should be the city's) is to get cheap delivery and handling of material at the machine. The question of delivery to the street and laying the asphalt can be easily checked up daily and a general hustle kept up, but the other end of the work is where expenses creep in and are very hard to detect.

In actual practice it will be found that more labor-saving appliances can be used on a portable plant than on a stationary plant, and, every man employed being in full view of the foreman, better results can be obtained.

The safety of St. Paul's Cathedral, London, Eng., which has caused a great architectural controversy for several years, continues to exercise the minds of engineers. It has produced the suggestion that the foundations of the cathedral should be immersed in a moist earth tank. It is proposed to utilize the blue London clay subsoil as a floor on which to build a reinforced concrete wall below the street level of the cathedral and then water the enclosed earth by vertical perforated pipes.

Examples of Poor Design and Improper Operation of Small Water Purification Plants

THE fact that small water purification plants are frequently abused in their operation is, as we have before stated, well known to engineers. It is with a view, therefore, of supplying engineers with additional data on this point, for use as illustrative examples in their efforts to impress upon city officials the importance of competent operation of such plants, that we are here publishing an abstract of a paper recently presented bv H. P. Letton, Sanitary Engineer of the United States Public Health Service, before the New England Water Works Association.

It very frequently happens that when a small water purification plant is installed in connection with a water works system which has been in operation for some time, perhaps for several years, that the man who has had charge of the pumping station takes on the operation of the purification plant as an additional duty. It is very uncommon, indeed, for men of this type to understand the process of water purification, even in its fundamentals. In connection with the discharge of his duties Mr. Letton has had an unusually good opportunity to observe the more common faults in the design and operation of the type of plants here under consideration and he mentions the following examples.

Examples of Poor Design

The worst example cited related to a plant of 1,000,000 gals. daily capacity. The water supply, obtained from an artificial lake, was highlv colored, due to passing through cedar swamps. The water flowed from the lake to the coagulation basins by gravity. In this basin, which was merely a wooden tank, a period of less than 20 minutes ordinarily was employed for coagulation and sedimentation purposes. This period was still shorter in times of high water consumption. Moreover, the coagulation basin was set at such a high level that in times of low water in the lake it was necessary to by-pass raw water around the basin in order to maintain the necessary supply. The filter plant consisted of four rapid sand, circular, wooden tank filters, operated by gravity and fed by a gravity flow from the coagulation basin. The filters were not equipped with either loss of head gages or rate controllers. The beds were not agitated during washing because the rakes provided for that purpose were fitted up for water motor drive and the necessary water pressure for actuating this motor was lacking. After leaving the filter the water passed to a suction well giving less than 30 minutes' storage. A small solution pump, for pumping a solution of sulphate of alumina into the raw water just above the coagulation basin, was supposed to be driven from the main shaft which drove the pumps of the distribution systems. It was learned, however, that this solution pump was normally out of service and that for the greater part of the time no coagulating chemical was injected into the raw water. Upon making an analysis of the raw water it was discovered that it was slightly acid, probably due to humic acid taken up by the water in passing through the cedar swamp previously mentioned. Under these circumstances the addition of the sulphate of alumina would have been useless. Analyses were made of both the raw and filtered water and the improvement shown by the filtered over the raw water was but slight. The color of the filtered water was at times at 200 p.p.m.

Mr. Letton investigated two other plants in which acid waters were being treated with sulphate of alumina only. Among the small plants inspected rate controllers and loss of head gages were seldom found, and the methods employed in controlling the chemical feed were in most cases very crude. Only a few calibrated orifice boxes were found in service. Two gravity rapid sand filters, which heated waters of high-organic content and frequently turbid, were not operated in conjunction with coagulation basins. This led to too frequent washing of the filter sand and the bacterial efficiency of the filters was correspondingly lessened, and operation costs were increased.

One large pressure filter was found treating a turbid water without sufficient time for coagulation. The effluent from this filter was frequently turbid and sometimes contained aluminum hydrate. Another plan, a slow sand plant, had less than 1 ft. of filtering sand and the capacity of the accompanying clear water well was about a half hour's supply. The rate of filtration consequently fluctuated exactly as the demand and almost no advantage resulted from filtration.

At one rapid plant raw water was used for filter washing because the clear water basin was so small. Still another plant was not designed so that it could filter to waste. Accordingly when it was necessary to gain access to the strainer system the dirty water in the bed was discharged into the clear well.

Examples of Faulty Operation

Although good results in rapid sand plants are so largely dependent upon the proper use of the coagulant, Mr. Letton observed great ignorance on this point on the part of operators of small plants. At several plants the operator measured alum by the pailful per day, without knowing the weight used or the proportion to the water treated. A few operators stated that they increased the amount of alum somewhat when the raw water was turbid, but the increase was governed only by the operator's imperfect sense of proportion and not by precise measurement of any kind. In only a few plants inspected was it found the practice to regulate the dosing by the results of making alkalinity and turbidity tests. Only a few of the operators could accurately make the alkalinity tests. Only two plants of less than 20,000,000 gals. daily capacity maintained laboratories, and even in these the chemical and bacteriological tests were made under the direction of non-resident specialists, the operators who made the tests being unable to interpret them or to use them as a guide in operating the plant.

At one plant the operator was too lazy to wash the filters sufficiently often and they clogged badly. This decrease in filtered output was made up by by-passing raw water around the plant. At another plant the beds were washed too often and the bacterial efficiency was low and the cost of operation was high. At this plant over 10 per cent. of the water filtered was being used for wash water.—Engineering and Contracting.

The Design of Sewage Treatment Works in Saskatchewan

SUGGESTIONS as to the design of sewage treatment works for municipalities in the province of Saskatchewan are contained in a government bulletin, an advance copy of which has reached us. It is pointed out that these suggestions are intended only as a guide and not as a limitation upon originality in design where modifications may be necessary to meet the requirements of the local conditions. The suggestions follow:

1.—Screening.

(a) That where sewage is to be pumped, provision be made for screening, cleaning the screens at regular intervals, and for removing and disposing of screenings.

(b) That where works are of a character producing a large quantity of screenings, mechanical means be provided for their removal.

2.—Grit Chambers.

(a) The function of grit chambers (or detritus tanks), being to arrest the heavier mineral particles carried in suspension, the construction of such tanks, is, generally speaking, unnecessary in this province, where the majority of sewage systems are designed on the "separate" principle.

(b) That in special cases where sand or other mineral particles cannot be kept out of the sewerage system, it is advisable to introduce grit chambers.

(c) That these be constructed in multiple compartments to take care of the varying volume of flow.

(d) That a lineal velocity of one foot per second be aimed at, calculated to retain the heavy mineral, but not the organic matters.

3.—Pumping.

(a) That where it is necessary to raise the sewage at the works, it is advisable that all machinery be in duplicate with alternative forms of power in case of failure.

(b) That appliances for raising sewage be specified with reference to efficiency in dealing with solids.

4.—Sedimentation.

(a) That there be at least two sedimentation tanks.

(b) That such tanks be so constructed that the precipitated solids are automatically and continuously removed from that portion of the tank in which precipitation takes place, and that a tank or chamber combined with, or separate from, the sedimentation tank, be provided, into which the precipitated solids may pass by gravitation immediately following treatment.

(c) That consequent upon the modern requirement of the continuous removal of sludge as above stated, all base slopes of sedimentation tanks be made as near to the perpendicular as is practicable, relative to general construction.

(d) That the tank capacity be equal to one-fifth of the dry weather flow in twenty-four hours, or equal to three hours' flow calculated upon the twenty-four hours' dry weather flow taking place in fifteen hours.

(e) That the cross sectional area of the tanks provide a velocity of flow of not more than .05 foot per second, while lower velocities are preferable. Flows may be either vertical or horizontal.

(f) That consideration be given to the design of the inlets and outlets with a view to ensuring uniformity of flow throughout the breadth of the tank, and the absence of stagnant sections; and that all channels and parts of the tanks apart from the sludge storage area, be so constructed that no solids are retained.

5.—Sludge Storage.

(a) That the overall depth of the sludge storage chamber from the surface of sewage in sedimentation tank be generally not less than fifteen feet. Greater depths may be adopted, producing a more concentrated form of sludge.

(b) That in deep tanks, wherever possible, provision be made for breaking up the sludge at the inlet to the sludge removal pipe.

(c) That the capacity of the sludge storage chamber be equal to at least four months' precipitation of sludge, containing 85 per cent. of water. Greater storage capacity is preferable as septic action is delayed in winter months. The cubic capacity of the sludge storage chamber shall be taken as only that space which is below the level of the deepest point of the sedimentation tank. In general, the average accumulation of sludge may be taken as three and a half cubic yards per million gallons of sewage on the above basis of dilution.

(d) That ample provision be made for the escape of gases from the surface of the sludge storage chamber.

(e) That pipes for the conveyance of sludge be of an internal diameter of not less than eight inches and that the inclination of such pipes, where the sludge is discharged by gravity, be at least 3 per cent. and preferably 5 per cent.

6. Biological Filtration.

(a) Where a dosing or siphon chamber is constructed to regulate the flow of the sewage over the surface of filter beds, that the capacity of such chamber does not exceed a ratio of two gallons of sewage to each square yard of filter surface. For instance, if the area of the filtering surface be two hundred square yards, the capacity of the dosing chamber should not exceed four hundred gallons, representing a dose of one-half inch depth of sewage over the whole surface of the filter.

(b) That the depth of the filter media be not less than four feet and preferably seven feet.

(c) That the filter media for effluents from the above form of tank be composed of hard broken stone or other suitable material, broken from one inch to two inch cubes.

(d) That the surface area of filtering media for domestic sewage be in proportion to the population using the sewers, i.e., in proportion to the amount of oxidisable matter present in the sewage.

Where a high degree of oxidation is required, the ratio of population to surface area of filter media should be approximately 17,500 persons to the acre (or 275 square yards per 1,000 population).

This corresponds to a rate of filtration of 1,750,000 imperial gallons per acre per day, or 155 imperial gallons per cubic yard per day (assuming depth of filter media to be seven feet) at a per capita flow of 100 imperial gallons per day.

The efficiency of filters will not be materially affected by increasing the rate of filtration during periods of storm to say three times the above stated rate, provided that the increase in volume is due to clear water.

In cases where the volume of dilution at the point of final discharge exceeds twenty times the volume of the sewage effluent, higher rates of filtration may be adopted.

(e) That the method or apparatus adopted for the distribution of liquid over the filter bed, shall ensure a uniform distribution over the whole surface.

(f) That all filter beds be drained at the base by the pipes or preferably by means of a false floor over the entire base of the filter.

(g) That sufficient provision be made for ventilation to allow of oxygen being present at all times and in all parts of the filter bed.

7. Humus Settling Tanks.

(a) That it is generally advisable to provide settling tanks for the removal of the humus which is unloaded by the filter beds from time to time.

(b) That such tanks be constructed in every case where disinfection of the final effluent is adopted.

(c) That humus tanks have a capacity equal to one forty-fifth of the dry weather flow in twenty-four hours, or equal to twenty minutes' flow calculated upon the twenty-four hours' dry weather flow taking place in fifteen hours.

(d) That it is desirable that such tanks have separate storage compartments as in the sedimentation tanks above described.

8.—Disinfection.

(a) That where chloride of lime is used for the disinfection of the final effluent, provision be made for weighing, measuring and storing the disinfectant in a dry covered building.

(b) That the period of contact between the disinfectant and the sewage be not less than fifteen minutes. An open pond or lagoon will serve this purpose.

9. Effluent.

That the effluent from the works be discharged into the watercourse or lake in such a manner as will ensure a maximum amount of dispersion.

10.—Housing of Tanks and Beds.

(a) That all parts of the works containing sewage under treatment be housed to conserve the latent heat of the sewage during low temperatures and to prevent fly nuisance in summer.

(b) That such covers be designed to enclose the minimum amount of space, at the same time giving room for accessibility and inspection.

(c) That with properly designed covers the introduction of artificial heat is unnecessary in sedimentation tanks, and may be obviated in filter beds.

(d) That provision be made in all covers for the access of light and for efficient ventilation.

11.—Laboratory.

That wherever the size of a municipality or other circumstance warrants its construction, a small laboratory be provided and equipped in which simple tests may be made of the sewage and effluents.

12.—Laying out the Surrounding Grounds.

That provision be made in the specifications and estimates for laying out, grading and improving the appearance of the surrounding grounds by terracing and seeding the slopes.

A rope railway 75 miles in length will be built in India. It will connect the rich country in the vale of Kashmir with the plains of the Punjab over the Himalayas. The line, it is claimed, will be the longest in the world, the present longest being 22 miles and located in Argentina. Sections will be 5 miles long and most of the spans will be 2,400 ft. The steel towers, some of which will be 100 ft. high, will be braced, and double 1½-in. cables, 9 ft. apart, will carry the steel cars. The carrying capacity of these cars will be about 400 lb. The estimated cost is $1,600,000.

Exporting twisted steel reinforcement bars to the Pacific Coast by the Panama Canal from England and the Continent was discussed in a recent report from the United States Consul at Liverpool. This report quoted square or round bars at $22.14 and $29.19 f.o.b. at Antwerp and Liverpool respectively, plus cost of twisting, thus making it evident that there is no prospect for exporting English steel to the Pacific Coast at present. The report also states that although there are in the Liverpool district two large manufacturers producing reinforcement bars, most of the bars used in England are imported from the Continent.

Power Development at Saxon Falls*

Six-foot Pipe Line and Surge Tank, Both of Wood Staves, Receive Water Impounded by Multiple-Arch Concrete Dam

A Hydro-electric development of 1250 kw. has recently been completed on the Montreal River, four miles above its mouth. The power plant is located 17 miles northward of Ironwood, Mich., and 25 miles east of Ashland, Wis. This is the third water-power station put in operation by the Ironwood & Bessemer Railway & Light Company. The power is to be used for lighting and street railway operation in Ironwood and Bessemer, Mich., and Ashland and Hurley, Wis. The first installation of the plant comprises two 1,000-h.p. units, but the ultimate development will have double this capacity.

Hydrographic Conditions

The Montreal River, the boundary line between Michigan and Wisconsin, has a drainage area of 280 square miles above Saxon Falls, with a mean precipitation of from 32 to 40 in. per annum. At Saxon Falls the river has a drop of 64 ft. With a 26-ft. dam this fall, together with the rapids in the river above and below, gives a head of 135 ft. The dam is located 1,900 ft. above the power house. During the last year the minimum discharge of the river has been as low as 50 sec.-ft. The maximum discharge has not been ascertained, but from flood marks and other data it has been assumed that flood waters should raise the river 6 ft. above low stage, and the dam was, therefore, designed to take care of a rise of 8 ft.

Both the Montreal River and its principal tributary, the Gogoshungen, or west branch, have sites suitable for storage reservoirs, and four such locations have been surveyed, one on the headwaters of the Montreal River and three on the Gogoshungen. About 25,000 acre-ft. will be available in the four storage reservoirs.

The company has steam-power plants aggregating 1,500 kw. at Ashland, Ironwood and Bessemer, which were in operation before the water power plants were built. These stations are maintained as auxiliaries in case of breakdowns or other trouble at the water-power stations. Two of the plants are in the same building as the car barns; in the other is housed the principal sub-station. The cost of keeping fires banked under the boilers is, therefore, small.

Dam

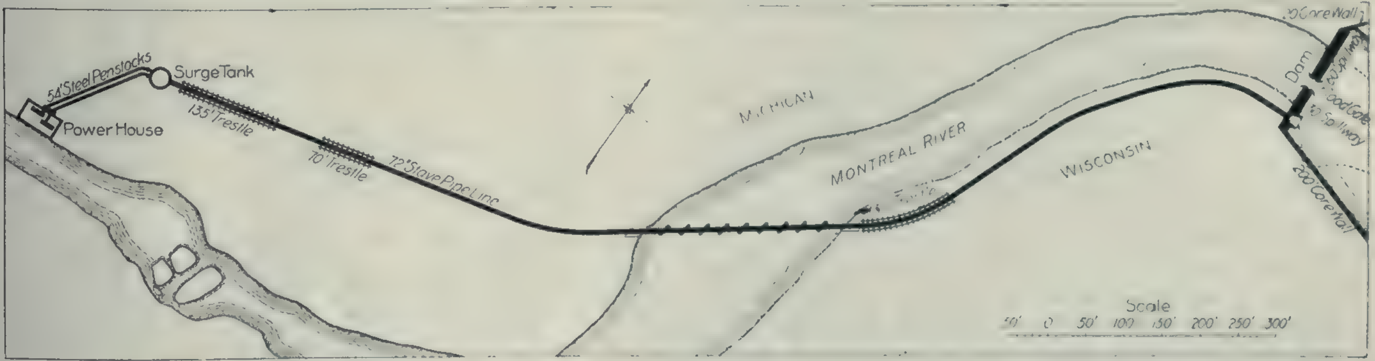
The dam is 190 feet long. Its site is at the head of the rapids and just below an enlargement of the river basin, where the banks are high and the stream is narrow; there is a fairly good sandstone foundation. The type decided on involves concrete piers 5 ft. wide, 44 ft. long and spaced 16 ft. on centers. The piers were designed for an ultimate height of 30 ft. Their front faces have been carried up only 18 ft. and made heavy enough to take care of the water pressure to that height. The piers were built of such shape that, when the dam is raised, they can be made longer and more massive. At present the space between piers is closed with timber stoplogs in five of the bays, the other four having vertical reinforced-concrete arches. One bay was built for a Tainter gate 11 ft. 7 in. wide by 17 ft. high. When the dam is raised it is intended either to build it of reinforced concrete or fill in between piers with vertical or inclined arches.

Underneath the dam a cut-off wall was sunk into the rock from 5 to 9 ft., according to the character of the stream bed. Holes 8 ft. in depth were put down on 4-ft. centres in the cut-off wall and the piers. In these holes were placed ⅞-in. square, twisted rods for anchorage. The concrete in the dam was placed from a concrete tower, 70 ft. high, located on the south side of the river. From this tower steel chutes conveyed the concrete to all parts of the dam. Gravel for concrete was obtained from the river bed and from a pit 2½ miles from the site, from where teams hitched to sleighs hauled 3 cu. yd. per trip.

The headworks are equipped with a gate 7 ft. wide by 7 ft. 10 in. high, operated by a gate hoist so adjusted that the gate is lowered by gravity. Two men can raise it in about ten minutes. The trash rack is made of 2 x ½-in. bars spaced 1½ in. apart. In order to avoid sharp curves in the pipe line the head gate is placed on the Wisconsin side of the river. The power house was built on the Michigan side because of a more protected location.

Pipe Line

The pipe line is 1,880 ft. long, made of 2½-in. hemlock staves cut to form a 72-in. diameter circle; 43 staves are required to form its circumference. The staves are cut to widths of 5⅝ in. outside dimension and 5¼ in. inside. A kerf, 1 in. deep, is sawn into the ends of the staves for 10-gauge sheet-iron galvanized tongues. The pipe is banded with ¾-in. mild



Relation of dam, pipe line and power house of Saxon Falls hydro-electric development.

---

* By C. A. Alderman in the Engineering Record.

steel bands with malleable iron shoes, spaced from 5⅜ to 9 in. apart, depending upon the pressure, which varies from 8.84 to 15.75 lb. per square inch. Where the pipe rests on the ground timber saddles spaced 4 ft. apart are used to support it. These saddles also serve as forms for the construction of the pipe. The pipe is backfilled with earth to within 12 in. of its top. Where valleys are crossed the pipe rests on timber trestles composed of four 10 x 10-in. posts with cap and sill of the same dimensions. The bents are spaced 7 or 9 ft. on centers, according to their height. On these bents the pipe is supported by four 7 x 12-in. stringers.

Owing to the topography of the country it was necessary to place the headworks on the Wisconsin side of the river and the power house on the Michigan side, thus creating a river crossing. Nine concrete piers and two abutments, 3 ft. wide on top, 5 ft. on the bottom and 16 ft. in length, were spaced 26 ft. 7 in. apart across the river. Two lines of 15 in. I-beams support the pipe on these piers. The line is fairly straight, with the exception of one curve of 128 ft. radius and a subtended angle of 36 deg. 40 min. near the headworks. It was, therefore, necessary to keep the hemlock staves in a steam box for about two days, after which period they were bent under pressure with a device rigged up on the ground.

Surge Tank and Penstocks

The 72-in. pipe line discharges into a 24-ft. diameter surge tank, 56 ft. high, built of hemlock staves sawed in a local mill. The lower 36 ft. are made of staves 3½ in. thick, the staves for the upper 20 ft. being 2¾ in. thick. One hundred and sixty staves were required to form the circle. A reinforced-concrete casing, 12 ft. high, is built around the base of the stand-pipe. Considerable attention was given to the design of the casing to make it strong enough to withstand the water pressure. One 72-in. pipe enters on one side and two 60-in. steel pipes leave from the other side. Below the hole formed by the entrance of the pipe line the casing is reinforced by twenty 1-in. square, twisted rods placed in horizontal rings. At the top of the casing above the pipes are placed sixteen rods. Between the upper and lower rings there are a sufficient number of trussed rods placed vertically to transmit the stress to these horizontal rings. The staves of the surge tank are banded with ⅞-in. mild steel bands spaced from 3½ to 7½ in. apart.

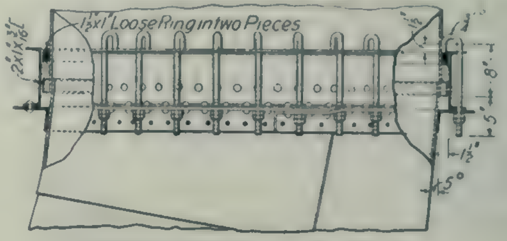
Seventy-two inch wood-stave pipe carried on longitudinal I-beam stringers.

The 54-in. steel penstocks are of 5/16-in. metal for the lower 60 ft. and of ¼-in. metal for the upper 57 ft. They are spaced 7½ ft. on centers. One of them was furnished by the waterwheel manufacturers and the other was built at a local boiler works. Reinforced-concrete anchorages, 6 ft. square and 6 ft. high, are placed underneath the penstocks and spaced 28 ft. 8½ in. on centers. Two ⅞-in. rods extend from 4 to 6 ft. from each anchorage into the rock. Penstocks are on a 40-deg. incline with the horizontal.

Each penstock is provided with a 60-in. flutter valve at the top of the pipe line. A 6-in. relief valve is placed in the penstocks adjacent to the flutter valves.

Power House

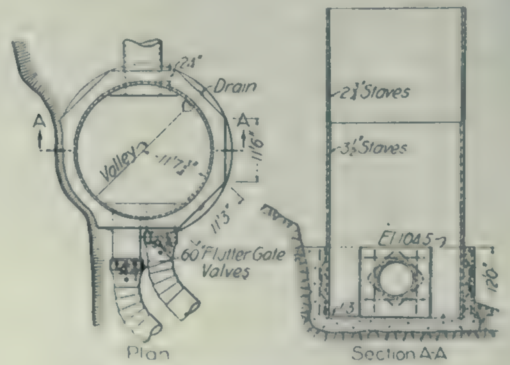
The power house is 30 x 53 ft. and is built of concrete on the Michigan side of the river, about 200 ft. below the falls. It was placed on this side of the river in order that it might be protected from floods, there being a projection of land into the river just above the power-house site. Both the power house and tailrace were excavated in the solid rock to a considerable depth.



Detail of pipe expansion joint.

The equipment consists of two horizontal 26-in., double-discharge Leffel waterwheels operating at 600 r.p.m. and using 83 sec.-ft. of water at a 135-ft. head to produce 1,000 h.p. Directly connected to the turbines are 625 kw., 2300-volt General Electric generators. The speed regulation of the units is accomplished by Lombard waterwheel governors. Two banks of three 200-kw., 60-cycle transformers step the current from 2300 to 33,000 volts. Two 14-kw., 125-volt exciters are belted to the generator shafts. One electrolytis lightning arrester, a switchboard and the necessary meters and recording apparatus complete the equipment.

It was decided to use this size of unit in order that full advantage could be taken of the stream flow, one unit being of the right size to take the minimum discharge of the river without storage and two units taking the discharge at mean ordinary stages. When storage reservoirs are built additional wheels may be installed of the same or larger size, depending upon whether a part or all the storage capacity is at first put into service.



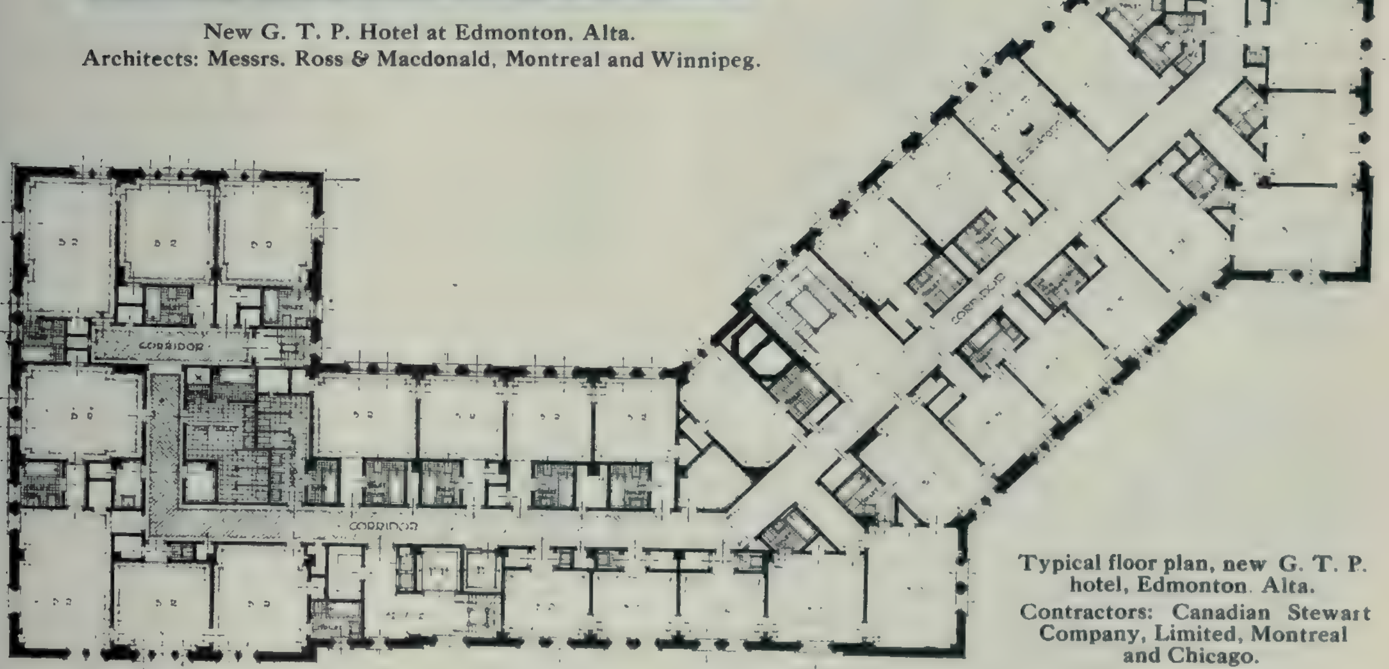
Wood-stage surge tank.

The work was done with company forces by day labor, camps suitable for the accommodation of one hundred men being maintained at the plant. All material and equipment were hauled by teams about three miles over a road constructed especially for the installation.

The New G. T. P. Hotel at Edmonton

THE Canadian Stewart Company, Limited, of Chicago and Montreal, have about completed the erection of a large hotel in Edmonton for the Grand Trunk Pacific Railway. This building is the second of a chain of hotels which the railway is building throughout the length of the road. In plan the building is a modified L-shape, 240 feet long by 190 feet wide in its extreme dimensions. The site, while convenient to the business district, overlooks the valley of the Saskatchewan River and affords a fine outlook over the city. The building is eight storeys high, with the steep pitched roof characteristic of the French chateau. The ridge of the roof in the centre wing is 177 feet above the pavement. The exterior is entirely of limestone, with granite base course, the high copper roof heightening the coloring of the stone to a lively gray. There will be a total of about 225 guest rooms, with 125 private baths attached. The total cost will be one million dollars. The architects are Messrs. Ross & Macdonald, of Winnipeg and Montreal.

New G. T. P. Hotel at Edmonton, Alta.
Architects: Messrs. Ross & Macdonald, Montreal and Winnipeg.



Typical floor plan, new G. T. P. hotel, Edmonton, Alta.
Contractors: Canadian Stewart Company, Limited, Montreal and Chicago.

No particular difficulties were encountered in the excavations for the footings and except for the intricacy of the framing there were no particular engineering difficulties to overcome. The basement walls and the footings are of concrete and the superstructure steel, with concrete floors. One hundred tons of cast iron were required for the column bases, and 2,750 tons of structural steel were supplied by the Dominion Bridge Company, Limited, of Winnipeg, and erected by the general contractors. The floor slabs are 4 inches of concrete, reinforced by Clinton wire cloth. The roof framing is structural steel, with steep slopes laid with 3 in. book tile and covered with 24 gauge copper, and deck slopes laid as floors and covered with a 5-ply tar and gravel roof. The exterior walls are, in general, 4 inches of stone, with 8 inches of brick backing, furred with 4 in. gypsum blocks and plastered, leaving a 2-in. air space between the outer wall and the furring blocks. Some 60,000 cubic feet of Indiana Bedford limestone were used, with a million and a quarter common bricks. All interior partitions are 4-inch gypsum blocks, except around stair wells and elevator enclosures, where 6-inch blocks are used. The exterior basement walls are furred with 2-inch blocks.

As will be seen from the typical plan, the centre wing is set back from the street corner, so that the entrance is approached through a loggia and court. On the entrance floor are the entrance porch leading into the main connecting corridor to the dining room and cafe on the left, and through a short lobby to the lounge and palm room on the right. The dining room is 50 ft. by 80 ft. and is to be finished with marble base, imitation Caen stone to the ceiling beams, with ornamental plaster ceiling. The doors and trim will be red oak. The cafe and bar are to have wood wainscotting, with arched openings, enriched spandrel panels and plaster entablature and ceiling. The cafe and bar are both 30 ft. by 50 ft. The lounge is 25 feet wide and 85 feet long, and opens direct into the palm room—an octagonal chamber 50 feet in width. These rooms will be decorated to conform to the general scheme of the building. Practically all the rooms on the ground floor will have marble base, with imitation Caen stone wainscotting and plastered ceiling. The floors of the dining room and cafe will be maple, laid on cinder concrete fill. The corridor floors and rotunda floor will be red quarry tile. The other floors will be granolithic. On the mezzanine floor will be the ladies' drawing room, a writing room, two private dining rooms and a banquet hall, with private ante-room.

There will be five bedroom floors alike, each with 39 bedrooms, 24 private baths, and two public toilets. On the sixth floor will be 19 rooms, 6 baths, and the laundry. On the seventh floor there will be but five rooms and on the eighth floor two rooms. All of the corridor and bedroom floors will be cement finished, the corridors to have an 8-inch mosaic tile border of appropriate design. The trim will be red oak, with red birch doors. The bathrooms will have 4 ft. 6 in. tile wainscotting, tile floors and plaster walls. All the stairways have cast iron risers and strings, with slate treads. The elevator enclosures are all kalameined metal.

The general contractors are the Canadian Stewart Company, Limited, of Montreal and Chicago, for whom Mr. Chas. Miller is the superintendent. The architects are Messrs. Ross & Macdonald, of Montreal and Winnipeg, for whom Mr. J. Beck is the inspector.

Concerning Concrete and Concrete Mixers

By James Casey

THE strength of concrete depends mainly upon the right selection of materials used, their natures, proportions, and thorough incorporation with each other. All aggregates should be clean, and the best are those that present rough and jagged surfaces, so as to provide a key. The sand should be coarse and sharp. If it is gritty to the touch, so much the better. The denser sands, being the heavier, are to be preferred. If more than five per cent. of clay or loam is present, sand should be washed, so as to get rid of excess. The sizes of the aggregates should be well graded, so as the mixed mass will, as far as practicable, be free from voids.

The heavier aggregates are preferred in the following order: granite, gravel, limestone, clay, sandstone, cinders. Porous stones (like sandstone) are relatively weak. In all cases, angular fragments are to be preferred, more particularly when the concrete is to be subjected to tensile strain, such as beams, warehouse floors, etc.

Concrete for Fireproofing

Slag and vitreous stones are best for fire-proofing purposes. Broken bricks and cinders are also good fire resistants. Cinders should be passed through screen before being incorporated. The size of stone depends upon where and how the concrete is placed. In heavy work, and when carefully deposited, stone that will pass through a three-inch ring are frequently specified. For floors, columns and reinforced construction, one-inch. For thin walls (4-inch partitions, for example), three-quarter inch. In extra heavy constructions, such as dams, bridge piers, etc., where the thickness is measured by the yard, stones of over three cubic feet are sometimes placed and with good results, with an economy of something like 25 per cent. In all such cases care should be taken that these big stones or rocks be kept at least two inches from all exposed surfaces. Work of this kind is, however, out of the order of regular practice, and the average contractor has seldom to handle it. We refer to it here to throw a sidelight, as it were, upon the entire problem.

The amount of cement to be used is determined by the voids between the larger aggregates. A simple way of determining the matter is to carefully measure and mix the sand and stone together and place in a watertight receptacle. Shake well down, then add water slowly, by tilting against interior side of receptacle, so water may rise gradually from the bottom, thus avoiding air bubbles. When water shows upon surface, stop. The volume of the water thus added represents (theoretically) the volume, or bulk, of the cement required, allowing perfect mixture. The prudent engineer always adds a margin for safety.

It may be laid down as a general proposition that the denser and heavier the concrete, the better. The weight of a cubic foot of ordinary concrete may be roughly placed at one hundred and fifty pounds; cinder concrete—the strength of which varies from 50 per cent. to 75 per cent. of ordinary stone or gravel concrete—weighs about one hundred and ten pounds per cubic foot.

Concrete may be rich, ordinary or lean, according to the service for which it is intended, and location in which it is placed. Rich concrete (proportions 1:2:4) is very strong, and well adapted for all kinds of reinforced construction; floors, beams, columns, cisterns, silos, walls, etc. Ordinary (concrete proportions 1:3:6) is suitable for massive work, such as embankment walls, abutments, foundations, sidewalks, etc. Lean concrete (proportions 1:4:8) is weak in tensile strength, but will answer well enough under compression: heavy foundations, sub-base for driveways and other road beds, etc.

Mixing

No matter how excellent the materials used and the scientific accuracy with which they are proportioned, the concrete will not be reliable unless the aggregates have been thoroughly, that is to say homogeneously mixed, throughout the job. This is a basic fact from which there is no getting away, and the contractor who desires to earn a reputation for being dependable (a considerable asset when figuring with reputable concerns), should bear it constantly in mind.

The old-fashioned hand-mix is, at least in the larger and more profitable kinds of work, out of date. Hand-mix, however well done, is seldom perfect, and is always relatively costly. Human muscles, however willing, tire and fail; machinery never tires, and works unerringly if built upon right principles.

There are now available all kinds of mechanical concrete mixers, suitable for all sizes of jobs, and to be obtained at moderate prices. A good mixer will pay for itself upon a single job of fair size, and leave a margin for profit.

Continuous and Batch Mixers

Aside from the vertical or gravity mixer, which has but a limited application, mostly in mining districts, and which consists of an enclosed shaft, in which are placed a number of interferences to divert the aggregates as they descend, a spray of water being introduced midway, concrete mixers may be divided into two general classes, continuous mixers and batch mixers. Quite a number of these mixers can be adapted to either form of delivery by the simple method of introducing a gate or cut-off, controlled automatically or by hand.

The best known continuous mixer consists of an open trough (placed horizontally, or with slight incline to delivery end to assist movement), fitted with a longitudinal shaft to which are attached blades and paddles, so arranged as to cut up and amalgamate the aggregates, and keep them moving onward. The materials are usually charged from a platform at rear end, by means of wheelbarrows or carts. Sometimes, however, in connection with heavy roadwork, materials are thrown direct from heaps ranged along the line of travel, upon a moving belt, by a gang of men engaged specially for that purpose. Water is introduced by means of an overhead sprinkling arrangement, delivery being at such points as may be selected. Sometimes the ingredients are mixed dry for the first half of the length of the trough. Mixers of this variety are equal to a large amount of work, two hundred yards a day being but a moderate output.

A small continuous mixer, with some novel features, has recently been placed upon the market. It claims a capacity of sixty yards a day. The mixing is effected in an open revolving dish, or pan, in which the materials are agitated by stationary plows, or blades. The desired proportions are delivered in the center of revolving disk through hoppers; cement and gravel from one side, stone from the opposite side. Under centrifugal action, the materials move gradually outward; as they do so they come under the action of the blades. The aggregates are first mixed dry, and then, about midway, they are wetted, the water being furnished from a tank. The mixer is provided with an automatic feed, and the discharge is effected at a given point in a continuous stream.

The popular rotating mixer now to be seen in operation everywhere, is substantially based upon the old cube mixer, with such additions as time and experience have suggested. This old-fashioned arrangement is merely a hollow steel box which revolves about a horizontal shaft that passes through it diagonally. The entire contrivance is mounted upon a stout timber frame. The box is charged at one corner, all outlets closed, aggregates revolved, and delivery effected at the opposite corner into a hopper.

The best known batch mixers to-day are of the well known rotary order. There are many differences in details between the various makes, but the underlying principles are substantially the same in all. In this line, as in other lines, competition has resulted in the survival of the fittest.

The modern rotary mixer consists of a revolving drum or double cone, the interior being fitted with strong deflecting blades, which mix and churn the aggregates in passage.

In some instances the service is direct, that is to say, the materials are wheeled onto a low platform, which is portable with the outfit, and is charged directly into the end of the drum, where it is caught by the charging blades, which are part of, and rotate with, the drum. This solves the problem of low charging and dispenses with hoisting hoppers. The drum is supported by trunnion rollers which tread against the flare of the track bands. It is rotated by pinions meshing into the gear bands, the power being transmitted through the shaft on which these pinions are placed.

The double-cone mixer, though built upon much the same principles as the above, differs in several important particulars. The full charge is delivered at once by means of a side loader, which is filled while the preceding batch is being rotated in drum and delivered, thus avoiding all delays and securing a perfect uniformity in the batches. The fact that the loader bucket is fitted at the ground level considerably facilitates operations.

In a well devised mixer of the double-cone variety, the drum is in perfect balance, the batch swings on its own center, and the tilting axis is below the center of gravity. In some makes, the tilting motion (operated by means of a lever) is reversible, permitting discharge at any part of the revolution.

The drums of this variety of mixer are variously supported, according to the ingenuity and preferences of the individual makers. Power is transmitted either by means of gearing or by pulley and continuous band.

Batch mixers can be had in all sizes, from a capacity of 2½ cubic feet up to two cubic yards and over. The sizes in greatest demand range from four cubic feet to thirty cubic feet. Sizes over the last, unless required for special purposes, are apt to prove unwieldly for the requirements of the average contractor, owing to weight and labor required in moving around, from place to place, and even upon the same job.

The smaller mechanical mixers can be worked by hand, if ordered that way. The medium and large mixers are operated by power and are furnished with boiler and steam engine, gasoline engine, or electric motor, as purchaser selects. Mixers are also furnished with water tanks and other attachments, as circumstances or special conditions may call for.

However carefully mixed, a certain amount of splashing attends the making of all concrete, and cement is hard upon machinery. To meet this trouble, some makers completely encase the more important parts so that dirt is absolutely excluded. The whole casing is kept constantly full of grease, keeping the runing parts cool and efficient. As this grease is squeezed out of the bearings in a gradual and constant flow, it excludes all entrance of dirt. This adds materially to the life of the mixer and renders its operations smooth and regular.

Care should be taken that the rotatory is not unduly speeded up, so as to establish a centrifugal action in excess of requirements, and in a way to counteract the gravity action which is desirable.

Concrete is not merely a question of quantity; quality has also to be considered. A thinner floor of rich, homogeneous concrete will support a greater weight under tensile strain than a thicker floor of poorer and ill-mixed concrete under the same conditions.

It is claimed for some of the rotary mixers that they will deliver a finished batch every minute, and at a saving of fifty cents per cubic yard.

The daily capacity of a mixer can be figured out by the contractor for himself, by checking upon the job, watch in hand, the number of batches turned out in any given time. Multiplying the number of batches in a day by the number of cubic feet in each batch will give the day's output in cubic feet. Divide by twenty-seven to reduce to cubic yards.

The demand for Portland cement concrete is steadily increasing, and is constantly introducing new features. There are reasons for this. Cement concrete is relatively cheap, easily made, and plastic so as to readily adapt itself to all kinds of forms. It calls for little skilled labor, which is a consideration in a trade in which wages are uniformly high, and competition keen. The material is impermeable, and a splendid weatherer.

The live contractor should, if he has not already done so, turn his attention to cement concrete work in all its shapes. Its use is not confined to the cities and larger towns. It has invaded the country, in every direction. It is now extensively used upon farms for the building of barns, silos, hog pens, etc. Its greatest developments have still to be witnessed.

In selecting a concrete mixer the following points should be considered: size, portability, simplicity of parts, price, balance, charging and delivery, homogeneousness of product, visibility of mix, etc. The last is an important consideration, as it enables the man in charge to see how mix is progressing.—Building Age.

Excavating and Cost Data on the Panama Canal

It is said that the two chief reasons originally claimed in favor of the lock canal at Panama were: cheaper first cost and the shorter time required for construction. The original estimates were for a lock canal at a cost of $139,700,000 to be constructed in 7½ to 9 years; for the sea-level canal the cost was put at $247,000,000, and the time of construction twelve to thirteen years. When it is further stated that the excavation required in the case of the lock canal was estimated at 95,955,000 cu. yds., and that for the sea-level canal of rather smaller section, at 231,000.000 cu. yds., some interesting facts are brought out. On the face of it the work involved in the sea-level canal seemed comparatively so great as to be almost prohibitive; yet instead of about 96,000,000 estimated, the lock canal will have necessitated by the time it is finished, excavation to an even greater extent than that originally estimated for the sea-level project. Again, though twelve to thirteen years were allotted to the excavation of 231,000,000 cu. yds., this length of time also being deemed to be prohibitive, practically this amount has been disposed of in about six years of serious work. Further, the cost of the sea-level canal, estimated at $247,000,000, was thought to be excessive, although by July next year a sum of about $299,000,000 had been expended on the lock project, the expenditure on construction works proper having been over $185,000,000.

Building an 85-ft. chimney in seven days' working time is a feat accomplished by the Wiederholdt Construction Company, of St. Louis, Mo., on February 15. The chimney was built on the company's system of reinforced-tile concrete with a reinforced-concrete foundation, and was erected at the plant of the Eggers Milling Company, of Hermann, Mo. The company informs us that the chimney was actually built, including its foundation, in seven days' working time and was completed and put in service just 16 days after the receipt of the order. During its construction there occurred, moreover, the heaviest snowfall recorded in ten years in St. Louis, and the temperatures were at no time higher than 20 deg. Fah. when work was started in the morning. The sand was heated before mixing and the tile was heated before placing. Fires were kept in the chimney constantly with all openings closed. The chimney has a total height of 85 ft., and is 3 ft. in inside diameter.

The New Civic Administration Building at Edmonton

The city of Edmonton have just completed and are occupying a six-storey office building, giving accommodation to practically all civic departments. The building is 72 feet wide, with a street frontage of 126 feet, and a rear length of 116 feet. It is of steel construction, with hollow-tile floors and partitions, and with exterior walls of face brick backed with 8-in. hollow-tile. There are 52,000 square feet of available office space. In addition to the usual civic offices, there is space for the Industrial Association, the Board of Trade, and other bodies, the office space totalling 52,000 sq. ft. The entire top floor is devoted to the City Engineer's office and in the basement is a municipal testing laboratory. The general contractors were Messrs. Purcell & Foote, of Edmonton, the building costing the city $240,000. The building was designed by Mr. A. M. Jeffers, City Architect.

Mr. J. B. Holdcroft, A. M. Can. Soc. C. E., Vancouver, recently secured the Canadian patent for a machine for measuring and recording on a continuous strip the volume of material carried by a belt-conveyor. The record is made on the strip in such a manner that during the day's run the degree of uniformity of the load and its average proportion to the maximum may be seen at once by inspection, and at the end of any period the strip may be removed and the actual number of cubic yards which have passed the meter read off by taking the area of the curve inscribed on the strip.

An interesting lecture was given recently at the Conservatoire des Arts et Metiers, Paris, by M. Moutier, the Chief of the Technical Department of the Nord Railway Company, on "The Channel Tunnel." After recalling the prehistoric days when France and England were joined by an isthmus, M. Moutier said that soundings had shown that the bottom of the Channel was composed of a bed of homogeneous impermeable chalk to a depth of 50 yards, perfectly suited for the proposed tunnel. It was estimated that the tunnel could be completed in seven years. It would cost £16,000,000, and should give a return of 6 or 7 per cent. on the money invested in it.

The city of Des Moines, Iowa, has had some successful experience in renovating old brick pavements by converting them into asphalt pavements. Where the brick has a good concrete foundation only a 1-in. layer of sheet asphalt binder is added. A recent piece of work was the resurfacing of a section of Walnut street. The pavement was of brick with sand-filled joints, on an apparently secure foundation; but it had become very rough and uneven. An iron hook was used to remove the dirt from the joints and indentations, after which the surface was swept clean with brooms. A pavement surface-heater was then applied, the brick surface coated with hot liquid asphalt, and a 2-in wearing surface of sheet asphalt applied.

Personal Mention

Mr. John Thorbourn, a well-known contractor and builder of Lindsay, Ont., died recently.

Mr. R. D. Farley has been appointed inspector of the work of constructing the new harbor at Kincardine, Ont.

Mr. Joseph Auguste Tessier, M.L.A., for Three Rivers, has taken office as Minister of Roads for the province of Quebec.

Mr. H. Doughty has resigned his position as superintendent of the Municipal Street Railway of Regina, his resignation to take effect April 30.

Sir Robert Perks, Bart., accompanied by his son, Mr. Malcolm Perks, arrived last week for the purpose of a business trip covering New York, Chicago, Montreal and Ottawa. Sir Robert is well known as one of the most prominent engineers and contractors in the world. He has been identified with many great undertakings, these including the Manchester Ship Canal and the port works at Buenos Ayres. He and his partner built the magnificent quay wall around Rio Janeiro Bay and carried out the vast land reclamation there, the work involving the expenditure of some $25,000,000. He is now sharing the responsibility of extending the port at Buenos Ayres at a cost of $35,000,000. Sir Robert takes a keen interest in the Georgian Bay Canal project—indeed he has linked this project with the tunnel under the English channel as constituting the two greatest public works now remaining to be carried out. A detailed biographical sketch of Sir Robert was published in our British-Featured issue of August 20, 1913.

Sir Robert Perks, Bart.

Mr. Robert W. Angus, Professor of Mechanical Engineering, University of Toronto, lectured recently before a meeting of the Engineering Society of the University on the proposed Victoria Park water supply scheme for the city.

Messrs. Cammell, Laird and Company, of Birkenhead, Eng., supplied the turbines for the Canadian Pacific steamer St. George. The installation was made at the Robins drydock at New York under the superintendence of engineers from Birkenhead.

Mr. Charles Marsh Clay, who as a civil engineer in Manitoba assisted to build railroads in the wilds of Canada, died March 11, at Roxbury, Mass. More than thirty years ago Mr. Clay gave up engineering to become head master for the Roxbury high school.

Mr. R. E. Palmer, M. Can. Soc. C. E., Chief Mining Engineer of the Rio Tinto Mines, in Spain, has been appointed Consulting Engineer of the company, with offices in London, Eng., where he will also act in a consulting capacity for several other companies.

Mr. William C. Kirkland, Principal Assistant Engineer in charge of drainage, Sewerage and Water Board, New Orleans, La., died in that city recently. Mr. Kirkland was born in Canada in 1861 and his early engineering experience was in railway work in the Dominion.

Mr. Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York City, recently delivered an illustrated lecture on "The Administration of Municipal Public Works" before the Graduate Students in Highway Engineering at Columbia University.

Mr. C. N. Forrest, Chief Chemist, Barber Asphalt Paving Company, Maurer, N.J., recently delivered an illustrated lecture on "The Essential Physical and Chemical Properties of Creosote for Wood Blocks" before the Graduate Students in Highway Engineering at Columbia University.

Mr. E. R. Doe, chief of the prominent contracting firm associated with his name at Victoria, B.C., died recently at the age of 47. Up to the time of his death he was engaged in constructing a steel bridge over Arbutus Canyon, B.C. During his career he successfully completed, in conjunction with his brother, a number of important engineering contracts in British Columbia.

Mr. Alexander J. McMillan of Vancouver, died March 3, after a brief illness. He was a civil engineer and for a number of years was engaged in railway construction in Oregon and California. At the time of his death he was chief construction engineer for the British Columbia mills, timber and trading company of Vancouver. He was born in Pictou, N.S., sixty years ago. He came to the Pacific coast in 1871.

Mr. George Westinghouse, famous engineer and inventor, passed away March 12 in a New York hotel, from heart disease. Mr. Westinghouse was in his sixty-eighth year. He was perhaps best known as the inventor of the air-brake which bears his name and which revolutionized railroading in this country. He founded many manufacturing companies in Canada, the United States and Europe, and his individual wealth and holdings have been estimated at $50,000,000. It has been officially stated that his death will not cause any change of policy or operation in connection with any of the Westinghouse industries.

Mr. George Creeford Browne, of Browneleigh-on-Hudson, South Nyack, N.Y., has intimated his intention of providing $10,000 to form a fund for the provision of a scholarship in Architecture in connection with the Architectural Department of McGill University under the management of Professors Nobbs and Traquair. The first award will be made at the close of the present session, when $500 will be forthcoming for a scholarship. Mr. Browne was formerly a prominent architect in Winnipeg. He was the youngest son of the late George Browne, who was, when he died in 1885, himself the oldest architect in Canada, having commenced practising at Quebec in 1830. Mr. Browne was born in Montreal and educated at the Montreal High School, and thereafter studied architecture in Europe. It is understood that one of his motives in founding this scholarship is the wish to perpetuate his father's name.

The firm of Fraser and Chalmers of Canada, Limited, Montreal, have been appointed Canadian agents for W. H. Allen, Son and Company, Limited, of Bedford, Eng., engineers and builders of steam and hydraulic machinery.

Canadian City Engineers

Mt. George D. Mackie, Moose Jaw, Sask.

Mr. George D. Mackie, whose appointment we recorded recently as Engineer-Commissioner of the city of Moose Jaw, was born in Perth, Scotland, and received his education at the Perth Academy and the Glasgow and West of Scotland Technical College. After receiving his training in the Perth municipal offices, he was appointed, in 1899, Assistant Road Surveyor of the County of Roxburgh. In 1900 he was appointed Town Engineer of Crieff, which has a population of 8,000, and while there—among other engineering works—installed a new gravity water supply at a cost of $50,000. This work consisted of five miles of cast-iron piping, a concrete reservoir (capacity one million gallons) and slow sand filters. Also he built a sewage disposal plant on bacterial lines at a cost of $30,000, laid out a public park and constructed many miles of concrete sidewalks. In 1905, Mr. Mackie was appointed Engineer to the Clydebank and District Water Trust. The population supplied by this body was over 40,000 and large quantities of water were sold in bulk to the shipbuilding yards in this district. While in Clydebank Mr. Mackie was associated with the laying of the first reinforced concrete water main in Scotland . This main was 15-in. in diameter and 11 miles long and was constructed to stand a head of 150 feet. It was constructed on the "Bonna" system and Mr. Mackie spent some time in Paris studying the construction of this pipe. Mr. Mackie made a long study of the best means of removing the peaty color from the Clydebank water supply, for which purpose he visited all the important slow sand and rapid filtration plants in Britain. The data collected by him were embodied in a paper read before the Institution of Municipal Engineers. In 1909 Mr. Mackie came to Canada and entered the employment of the John Galt Engineering Company, of Winnipeg and Calgary, for whom he installed a water supply system for Coldwater, Ont., sewers and street grading for Red Deer, Alta., sewerage system and water supply for Gleichen, Alta., and a sewerage system for the city of Cranbrook, B.C. Mr. Mackie was appointed City Engineer of Swift Current, Sask., in 1912, and leaves that appointment for Moose Jaw. He is a member of the Institution of Municipal and County Engineers of Great Britain and is on the Council of the Canadian Public Health Association.

Mr. George D. Mackie, City Engineer of Moose Jaw, Sask.

New President University of Toronto Engineering Society

Mr. E. D. Gray has been elected President of the University of Toronto Engineering Society. Mr. Gray, who is just winding up his third year's work in the Faculty of Applied Science, was born at Tillsonburg, Ont., in 1887, and is an Arts graduate of McMaster University, where he was prominent in both athletic and literary circles. Although only twenty-six years of age, Mr. Gray has had plenty of opportunity to familiarize himself with constructional practice, he having worked actively in the field for the last eight summers. His first connection was with the T. & N. O.; later he became associated with Mr. T. S. Scott, formerly Assistant City Engineer of Toronto; and he spent last summer in Vancouver as superintendent for the Columbia Bitulithic Company on the last link of the "King's Way," an asphalt road from Vancouver to New Westminster, which has reduced the distance between these cities to twelve miles, and promises much, according to Mr. Gray, to promote trade intercourse between the two cities. In 1911, at McMaster University, Mr. Gray was president of the Literary Society. It is worthy of note that while he combines literary with engineering tastes he confesses to a predilection for the contracting business.

Mr. E. D. Gray, the new president of the University of Toronto Engineering Society.

The Marion Steam Shovel in the New Welland Canal

In the excavation operations in progress on the new Welland Ship Canal, where a large number of powerful steam shovels and drag-line excavators are at work, it is interesting to record that on all four sections on which contractors are engaged the Marion Steam Shovel finds a place. All these shovels of the Marion type, as also the drag-line excavators now being installed, were furnished by Messrs. F. H. Hopkins & Company, dealers in railway and contractors' supplies, Montreal and St. Catharines, who are the Canadian representatives of the Marion Steam Shovel Company. The Hopkins firm have opened up an office and warehouse at St. Catharines, where a full stock of contractors' equipment and supplies is carried.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The city council of Westmount, Que., has placed before the citizens its proposals for borrowing about $1,200,000 for public improvements.

Mr. J. H. Dupont has been appointed building inspector and engineer of Lachine, Que., at a salary of $2,700 a year. He takes up duties on April 1.

A mass meeting of the citizens of Montreal, called at the invitation of the chamber of commerce, unanimously endorsed the project of constructing the Georgian Bay Canal.

The Ottawa water bill, which provides that the expenditure by the ratepayers of the capital on the thirty-one-mile lake scheme, at a cost of $8,000,000 is at present before the Private Bills committee of the Ontario Legislature.

The main building of the Standard Clay Products plant at New Glasgow, N.S., was burned down on March 12. The drying rooms and press plant were completely destroyed, the former being filled with pipe ready for the kilns at the time of the outbreak. The loss is estimated at about $60,000.

Papers were filed on March 12 in the first expropriation proceedings in Welland County to acquire right-of-way for the new Welland canal. The property expropriated is five and a half acres, partly in the village of Humberstone and partly in the township, and is owned by Jacob E. Barrick. The price offered by the government is $1,650.

Montreal City Council has returned to the Board of Control for the second time the recommendation for $1,453,252 for indemnities and expenses in the St. Joseph Boulevard expropriation case. At the same meeting sums of $312,919 and $251,499 were voted respectively for the provision of a new park and playground and for land purchase and expropriation.

The Royal Museum of Archaeology, on the south side of Bloor street, Toronto, completed recently at a cost of $400,000, was opened by H. R. H. the Duke of Connaught on March 19. The structure is 300 ft. long by 60 ft. wide, and the cost of construction and maintenance is borne equally by the Province of Ontario and the University of Toronto.

Work is progressing rapidly on the section of Danforth Avenue sewer from Winchester street to Logan avenue, Toronto. About 35 ft. of the sewer is mined each day, the bore having a depth and width of 7 ft., the sewer itself measuring 5 ft. in height and width. The work of construction is being carried out by the Godson Contracting Company and will be completed in a few weeks.

The Toronto civic works committee has approved of the principle of a scheme which includes extensions to Church street, Toronto and Teraulay streets, and the opening of Duplex avenue in North Toronto, the share of the cost to be met out of the general treasury amounting roughly to $2,500,000. A recommendation has been made to the City Council in favor of estimating and assessing the cost.

The Toronto civic works committee has decided on a new proposal for the rounding of the corners at Bay and Queen streets. The streets will be widened 5 ft. on each side; Bay street 96 ft. on one side and 50 ft. on the other, and Queen east and west streets a distance of 48 feet from the corners, which will be splayed. The new proposal, which is estimated to cost $178,000, can be carried out as a local improvement.

In a lecture delivered in Toronto on March 14, Mr. C. E. Chambers, Parks Commissioner, gave a graphic description of the plans for beautifying ravines and open spaces in and around Toronto. He said that in conjunction with the Humber Boulevard plan and the scheme for making use of the Humber and the Don valleys, some fifteen miles of ravines across the city would be utilized, giving a result which would be second to none on the continent.

A civic plan for the future development of Berlin and Waterloo is at present on exhibition in the first-named city. The plan, which was prepared by Mr. C. W. Leavitt, Jr., a New York engineer, provides for a civic centre in Berlin to be bounded by an extension of Duke , Queen, Weber and Scott streets. It is proposed to encircle the twin cities by a boulevard to take in the entire park systems. The removal of the G. T. R. freight sheds is recommended and a Union station is proposed to be located in its place.

The new dry-dock for damaged inland waterways vessels is the most recent scheme advocated by the municipal Board of Trade for the upper portion of Montreal harbor. A resolution urging the enlargement of the present Tate's dock at the canal basin or the construction of a larger dock, has been despatched to the Minister of Railways and Canals. It was pointed out that the Duke of Connaught dry-dock is built primarily for ocean-going steamers and that the cost of its operation makes its use almost prohibitive for small craft.

After holding four meetings, a special civic committee of Montreal appointed to study the tramway report of Mr. G. R. MacLeod, railway engineer of the Council, have adjourned sine die. This report recommended the construction of subways and the improvement of the tramways service, and although the committee held four meetings practically no progress was made. In view of the aldermanic elections, it was felt that the question should be considered by a new committee and that the interests involved were too important to be discussed by a dying committee.

The new wharves which are being constructed at west St. John, N.B., two of which will be ready for use next winter, will not only have a face and surface of concrete, but warehouses of steel (the first of the kind in St. John) will be erected upon them. These berths will also be provided with grain conveyors connected with the new C. P. R. elevator. Not only the building of the timber substructure but of the concrete surface of the wharves involves a great amount of work, and it will give employment to a very large number of men throughout the summer and fall.

The Ontario Car Ferry Company has placed an order with the Polson Ironworks and Shipbuilding Company for the building of a new Car Ferry at a cost of $500,000. The new ferry will be 318 feet long with 54 ft. beam and a draught of 20 ft. 6 ins. In addition to a carrying capacity of twenty-eight loaded freight cars, accommodation is provided for a thousand passengers. It will be constructed entirely of steel and in design will be a duplicate of car ferry number one, which plies between Cobourg and Charlotte. The conditions of contract require that the new vessel be ready for service before the spring of 1915.

Captain Coleman Hinskley is again agitating for the reopening of the Wolfe Island canal. He had an interview with Mr. W. F. Nickel, M.P., recently, with regard to making another request to the Dominion Government to dredge out the old waterway between Kingston and Cape Vincent.

With the object of meeting the housing problem of Toronto, the board of health has decided to enquire into the conditions brought to light by Dr. Hastings in his monthly report. The members have decided to constitute themselves a commission and a solution will in due course be submitted to the city council. Controller McCarthy has expressed the opinion that workmens' dwellings can be erected in the city limits and rented at a profit for $12 a month, if constructed on the English principle. The report on possible locations for the construction of such dwellings will be prepared by the assessment commissioner.

The Ontario Legislature has adopted a resolution urging upon the Federal Government the necessity for granting aid to develop the iron resources of the country. Discussing the question, Mr. R. R. Gamey pointed out that although there were large deposits of iron ore in Ontario and other provinces of the Dominion now lying idle or but little worked, the growing demand for iron and steel and also the demand for iron ore for smelting purposes were met largely by importation. He advocated a measure of assistance by the Parliament of Canada that would place the iron and steel industry on an assured footing.

The industries of Fredericton, N.B., are shortly to be added to by the addition of a concrete manufacturing plant. A company has been formed with the object of manufacturing concrete blocks and forms for building purposes. The new company is applying for a lease from the corporation and already plans are said to be maturing for the erection of several concrete buildings in that city. The new industry will be located in the old I. C. R. foundry and the head office will be at Gibson. Mr. H. C. McGrath, formerly masonry inspector of the I. C. R., will be the manager, and Mr. T. C. Burpee is appointed mechanical superintendent.

Damage estimated at $150,000 was caused by a fire which destroyed the Woodbine Hotel, King street West, Toronto, on the evening of March 17. The rear portion of the building, which was a comparatively new section, was totally destroyed and the lives of five guests were lost. As a result of the outbreak the City Council has decided to have a report made by the Chief of the Fire Department in conjunction with the Acting City Architect, as to the present condition, from the point of view of the public safety, of all public buildings, schools, hotels, theatres and concert halls. A permanent and more efficient system of inspection is urged.

It is claimed that the new bridge to be erected this year to connect east and west St. John, N.B., and provide for street car as well as general traffic, will be the longest spandrel-arch bridge in the world. The foundations are nearly completed and preparations are now being made for work on the superstructure. It will be the third bridge across the famous Reversing Falls, as there are already a general traffic and a railway bridge, but the former can no longer accommodate the traffic, and street cars cannot cross it. With a continuous street car service over the new bridge it is anticipated that building operations on the west side will in future be much more extensive.

The report of the provincial roads department for 1913 has just been issued by Hon. J. E. Caron. Discussing the government road policy, Mr. Caron points out that apart from the $10,000,000 provided by the act of 1912, the government annually pays for roads improvements from $300,000 to $600,000. According to the by-laws passed by the municipalities, and adding the provincial roads, there will be built in the next five years under the act of 1912 nearly 2,000 miles of macadamized or gravel roads. Whereas twenty years ago only $75 was spent by the government on roads improvements, in 1913 from July 1 to October 15 the government expenditure under this head was $1,592,392.

A deputation from the Kingston shipbuilding company waited on the committee of the board of works of that city recently and urged that steps be taken to have a track extended from the Grand Trunk inner station to their plant. Mr. J. F. Sowards said that the company had an opportunity of securing two contracts which would total $1,000,000, and which would mean work for 300 men for two years, but in order to secure this work the company required railway facilities. The Grand Trunk Railway Company were willing to lay a track (at the Shipbuilding Company's expense) from the inner station along Ontario street, but to render this project feasible the city would require to cut down the grade at William street.

Several firms have prepared plans and specifications for a reinforced-concrete viaduct across Bloor street, Toronto. About fifteen firms have also notified the city that they will tender on a steel superstructure. The situation now is that tenders for a concrete viaduct will be given equal importance with those for a steel one. It is unlikely that the Department of Works will be ready to call for tenders for the viaduct for a month or two yet, so great is the work in preparation of plans and specifications.

It is proposed to construct a pulp mill during the present year at Bathurst, N.B., to be ready for operation next May. A paper mill is also to be built which will produce a grade of paper that is in great demand and has hitherto been imported from the United States. The Bathurst Lumber Company, Limited, which has sawmills and controls 2,800 square miles of timber limits near Bathurst, has completed the organization of the Bathurst Pulp & Paper Company, Limited, which will have $3,000,000 capital. The plans provide for the development of an extensive water power on the Nepisiquit River, and transmission of the power to the plant at Bathurst. Legislation to enable the company to proceed with its work immediately is being sought at the present session of the New Brunswick Legislature.

Considerable progress is being made in blasting, excavating and levelling of the foreshore from whence the new government breakwater and piers will extend seaward at Victoria, B.C. The new piers, to be known officially as piers 2 and 3 and also 1 and 4, are to be constructed before the harbor programme, decided upon by the Dominion Government, is completed. The contract for piers 2 and 3 was let recently at about $2,250,000. Pier 2 is to be situated near the breakwater on the Ogden Point side. Its length extending straight out into the water will be 1,000 feet, and width 250 feet. Pier 3 will be 800 ft. in length on either side, with a width of 250 ft. Between the two piers on the landward side a concrete wharf 300 ft. long will be constructed. Mr. J. S. Maclachlan, Dominion District Engineer, is in charge of the work which will be one of the most extensive ever carried out on the Pacific coast.

With the awakening of Spring, Fredericton, the progressive city of the province of New Brunswick, comes forward with the announcement that a concrete manufacturing plant is to be established there. The field of the new company will be the eastern section of Canada. Mr. J. J. McCaffrey, proprietor of the Queens Hotel, Fredericton, is one of the promoters of the new concern. With him are associated Mr. H. J. McGrath, of Moncton, formerly concrete inspector on the I. C. R., and Mr. T. C. Burpee, formerly engineer of Maintenance and Way on the Intercolonial. Mr. McGrath will be manager and Mr. Burpee mechanical superintendent of the new enterprise. Already the company have been given the assurance of a considerable amount of work, both structural and ornamental, and there are two travelling representatives in the field. The Maritime Province is experiencing a great awakening at the present time, especially in the construction line, and the opportunities for a concern of this kind seem exceedingly bright. The company has purchased the old I. C. R. foundry and will install up-to-date machinery.

WESTERN CANADA

The special stockyards committee of the Calgary City Council has formulated a tentative proposal for organizing the Union stockyards in East Calgary. The scheme will be submitted to the C. P. R. immediately as a basis for negotiations.

An order-in-council was passed recently, authorizing the immediate purchase of Lang's Cove drydock site at Esquimalt. The next step will be the preparation of plans and specifications, after which tenders will be called. The dock will be one of the largest in the world, its length being 1,150 feet, sufficient to accommodate the largest ship afloat.

A deputation from various Western Ontario points waited on the government at Ottawa recently to urge immediate action with a view to providing proper harbor and grain-handling facilities at Goderich and other Lake Huron ports. The Great Lakes disaster last autumn was used as one argument for a more generous provision this session for improving the harbor facilities on the lakes.

The construction of the new six-storey addition to the present mercantile establishment of the Hudson's Bay Company at Fort Edmonton, is reported to be well under way and steel will be placed shortly. Contractors in charge of the work are confident that the new building will be ready for at least partial occupancy during the coming summer. The present building will be raised one storey on all floors connected with the new addition, giving a total floor space of 70,000 sq. ft.

Mr. D. A. Thomas, a Welsh coal operator, has arrived in this country with the object of meeting speculators from Vancouver and Seattle, in order to discuss the charter they are expecting to obtain from the Canadian Government for the development of coal and mineral lands around the Peace River into Athabasca, B.C. The scheme is said to include the construction of a railroad into the territory from the Pacific coast northwest, passing through the Chamois ground hog coal field, entering a country comparatively unknown as to its mineral resources.

The work of connecting up the big water supply pipe and the three distributing mains in Regina, Sask., was successfully carried out on March 8. Heretofore the water pressure for domestic purposes has been produced by gravitation, the water coming from the reservoir at Boggy Creek, a distance of eight miles from the city, and having a drop of about 50 feet in transit. Now, however, in addition to the pressure from gravitation, the water will pass through the new pump, which is one of the largest of its kind in the West, having a daily pumping capacity of 5,000,000 gallons. The reservoir is over 200 feet in diameter and 25 feet deep.

The civic bridges and railways committee are reported to have rejected the tender of the Robert McLean Company, at $248,900, which was the lowest, for the construction of the four bridges at Vancouver under the Hennibique system. The tender of the Union Contracting Company for the mushroom system in the plans of Mr. C. A. P. Turner, designing engineer for the bridges, amounted to $299,830. The committee took the view that to accept the tender of the Robert McLean Company would necessitate changes in the design, which would mean a delay of several months before the approval of the Great Northern Railway commission could be obtained.

Montreal Harbor Commissioners' Activities

DURING 1913 the Montreal Harbor Commissioners expended on capital account $2,461,794 while, in addition, a large amount was spent out of reserve on maintenance and repairs. The annual report, just isued, states that the railway line was completed to high level along the river front from Molson's Creek to Tarte pier. Two permanent transit sheds were finished and opened for traffic on the Tarte Pier. The dry dock site, providing a large basin for the new floating drydock, Duke of Connaught, and a large area of made land for the shipyard, was advanced almost to completion. Owing to alterations in the plans of Canadian Vickers, Limited, a portion of the quay wall at the head of the basin had to be removed, and the work is being done by the Harbour Commissioners, at the request of Canadian Vickers, Limited, and at their expense, and the return wall for the slip is now constructed to half level. The south-east slip wall was concreted during the season and the south-west slip wall is now under construction.

New quay walls of standard cribwork substructure and concrete superstructure were completed, having a total length of over 2,200 lin. ft., and 2,000 lin. ft. partly constructed. Railway tracks to the extent of about four miles were constructed and an additional one mile improved and relaid. The removal of the artificial works at Moffat's Island was greatly advanced and its ameliorating effects on St. Mary's current towards the close of the season was very marked. .

One of the important items of new work commenced was the construction of a large industrial wharf at Pointe-aux-Trembles. Another new work commenced was the construction of new transit sheds on the high level bulkhead wharves. A new electric hoist, with bridges connecting with the upper storeys of the sheds on the Alexandra Pier, was constructed during the season.

A commencement was made towards the re-construction of the superstructure of the wooden piers in the central part of the harbour, consisting of the substitution of concrete for the portion of the quay walls above low water level. This work is very difficult to accomplish, owing to the fact that work can only be carried on during the absence of ocean steamships. Sheet piling was driven along practically the whole of one berth and it is proposed to carry this work on to a certain extent each year, so that the whole may be reconstructed before the wooden walls entirely fall. The portion of the crib work under water is practically permanent and does not require re-building. The sheet piling is being driven along the face of this cribwork, so as to add to its strength and for increased support of the heavy concrete wall, and also to permit of deepening the berths.

The conduct of the enquiry into the break in the water conduit at Montreal by the Board of Control appears to have caused dissatisfaction among a considerable section of the citizens, judging by a resolution which was passed by an emergency meeting composed of the Board of Trade, Canadian Manufacturers' Association and the Builders' Exchange on March 10, alleging that the investigation is not being conducted in such a manner as to bring out the facts connected with the design of the intake conduit and aqueduct enlargement recently reported upon by Messrs. J. A. Jamieson, R. S. Lea and G. R. Heckle; urging the appointment of an engineer to advise the investigation commission, and also that evidence should be taken as to whether the conduit was built in strict accordance with the plans and specifications,

Canadian Railroad Development

Track laying on the Lake Erie & Northern Railway has been completed across the Governor's road near Paris, Ont. The bridge work was carried out by the Hamilton Bridge Works.

The Minister of Railways, Hon. Frank Cochrane, has authorized a survey of the Intercolonial railways from Moncton to Halifax and Sydney, with a view to eliminating the present heavy grades, replacing light bridges with heavier steel structures, and ascertaining the cost and feasibility of a cut-off at Truro. In the memorandum issued by the general manager, Mr. Gutelius, it is asserted that by reducing the grades to a maximum of six-tenths the tonnage of the trains could be doubled, and by increasing the strength of the bridges heavier motive power could be used on this section of the line.

The contract has just been signed for remodelling a building at the corner of King and Germain streets for the St. John, N.B., headquarters of the Canadian Pacific Railway. It is a large brick building, but will be entirely remodelled and another storey added, so that the company may assemble there its various railway, steamship, telegraphic and other offices. Last year the company erected at west St. John a new million-bushel grain elevator, and the previous year they provided at the head of the harbor new freight sheds and a large amount of additional trackage. This year they will still further increase their trackage at west St. John, in connection with the two new steamship berths under construction there.

Montreal City Council has under consideration a report from the Board of Control regarding the proportion the city wishes to contribute towards the cost of elevating the Grand Trunk Railway tracks, within city limits, as decreed by an order of the Railway Commission in 1912. The law department have advised that the city should pay not less than $1,000,000 or more than $2,000,000 of the $6,000,000 which it is estimated the elevation would cost. Of these amounts the cities of Verdun and Westmount are to be asked to contribute a portion to be deducted from the amount paid by the city of Montreal.

A bill to provide for alteration of the plans of the Kettle Valley railway line to permit the Kettle Valley Railway Company to reach the Hope Mountains from Penticton by way of Princeton instead of Aspen Grove is before the Legislature of Victoria, B.C. Under the original plans and bond guarantee the line was to be built from Penticton on the way west from Midway, via Osprey Lake and Aspen Grove, with a long narrow dip southwards between these two points in order to get over the low mountain range there. From Aspen Grove the line would run almost due west to Coldwater Junction and Otter Summit, there to meet a line extended south from Merritt, and also to make connection at the same point with the suggested line from Otter Summit and Coldwater Junction over the Hope Mountains to Hope on the main line of the C. P. R. The line south from Merritt has been completed and the alternative section over the Hope Mountains is now in the hands of the graders. The approval of the authorities of the revised plans of the Kettle Valley Line to eliminate the Aspen Grove route from its main line, was obtained some time ago, and now the Provincial Government has also given its consent. The bill to be brought down will also provide for a spur south from Princeton to the Copper Mountain mining camps and another spur from the Kettle Valley Line to Franklin's camp, near Grand Forks. It is understood that the Great Northern will be given running rights on the Kettle Valley and C. P. R., via Merritt, until the Coquahalla line is completed.

At the instance of the British Ambassador, Secretary Garrison has called upon the army engineers to report upon the possible effect upon the level of the Great Lakes of a measure now pending before the United States Legislature, which would permit the diversion of a greater amount of water from Lake Michigan into the Chicago Canal in connection with the proposed extension of the Chicago park system. The Ambassador, Sir Cecil Spring-Rice, in a note to the States Department said the proposed legislation would encroach upon Canada's navigation rights guaranteed by a treaty between the United States and Great Britain

Industrial Notes

The Imperial Wire and Cable Company, Limited, and the Northern Electric and Manufacturing Company, Limited, have been amalgamated. The company will in future be known as the Northern Electric Company, Limited.

The Dominion Engineering and Inspection Company, of Montreal and Toronto, have been appointed to inspect the fabrication of the travellers to be used for placing the centre span of the Quebec bridge. These travellers will be manufactured by the Structural Steel Company, Limited, for the St. Lawrence Bridge Company.

The Great Western Railway Company of England has recently placed a contract with Herbert Morris, Limited, of Toronto, for the supply of all the Chain-Blocks which may be required during the year 1914. This is the thirteenth successive year in which the Great Western Railway Company has decided to purchase Morris Chain-Blocks.

The Industrial Engineering & Machinery Company, Limited, of Montreal, have just secured a contract for the complete installation of a large rock crushing plant, which is to be erected at Beauport, Que., for the Quebec Brick Company, Limited. The contract is being executed jointly by the Industrial Company and the Traylor Engineering & Manufacturing Company, of Allentown, Pa., the latter furnishing all the machinery. The plant is to be one of the largest and most modern in Canada, and will be electrically operated throughout. The quarry equipment, consisting of steam shovel, dump cars, locomotives and drills, is also being furnished by the Industrial Company. The shovel will be 3½-yard size, Marion-Osgood make, and especially adapted for rock work.

An engineering data book has been published which will enable users of power to select the correct Silent Chain Drives for their work and determine exact costs from list prices shown in the book. Besides giving complete engineering information on silent chain driving in simple and compact form. Data Book No. 125 describes many uses of silent chain for the efficient transmission of power and gives specific reasons and illustrations showing application in a large variety of uses. Link-Belt Silent Chain is a series of links connected by joints which consist of segmental case-hardened bushings and case-hardened steel pins. The chain is as flexible as a leather belt—as positive as a gear. Its rated efficiency is 98.2 per cent. on actual test. It will transmit any amount of power quietly. Over 200,000 installations, we understand, were drawn upon for the information contained in this data book. The book is the only work of its kind and consists of 112 pages, bound in flexible red cover. Copies can be obtained free of charge by addressing the manufacturers, Link-Belt Company, 39th Street and Stewart Avenue, Chicago.

ESTABLISHED 1886

Contract Record
and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **April 1, 1914** **No. 13**

Principal Contents

Facts and Figures about Building 379
Why are Architects' Estimates Always Low? 380
Contractors and Conservation 381
By R. O. Sweezey
Methods Employed in Strengthening an Old Factory Building 383-5
Rapid Foundation Work 385
Highway Bascule Bridges of the City of Winnipeg. 386-393
By H. A. Mackay
The Art of Making Rapid and Reliable Preliminary Estimates of Cost 393-6
By Allen Hazen
Constructional Features of the B. C. Division of the Canadian Northern Pacific Railway 396
Specifications for Reinforced Concrete Highway Bridges and Culverts 397-9
Waterproofing Masonry 399
J. W. B. Blackman on Town Planning 399
Bricks and Brickwork 400-2
Bonds in Brickwork.
Brick Roads without Permanent Curbs or Edging.
Design and Construction of New Veterinary College, Toronto.
Profit or Loss with the Steam Shovel 402
Letters to the Editor 403-5
A. R. MacCleave, E. W. Hubbell, Jno. M. Lyle, P. M. Sauder, R. W. Macintyre.
Personal Mention, featuring Col. W. M. Davis and Mr. R. [illegible]. Leslie 406
Constructional and Industrial 407-410

Facts and Figures About Building

BUILDING prospects for the present year are exceedingly bright in most parts of the country. February is scarcely a month in which to look for much actual construction work, or even building projects, and the February of 1914 proved no exception to the rule. From the list of building permits issued for February and also for the two months of the present year we find that of the total of forty-one cities from which records have been received, a decrease to the extent of $4,800,478 is recorded for the two months, and a decrease of $1,825,543 for the month of February, the total value of permits issued during the latter month being $3,923,393, as against $5,748,938 for the same period in the previous year. The record for the two months this year is $6,829,211, which represents a large reduction on the figures for the same period in 1913, the latter being $11,629,669. Decreases are also recorded in returns from twenty-four eastern cities. The amount for February, 1914, was $2,525,587, as against $3,217,177 in the corresponding period of last year, being a reduction of $691,590. The record for the two months of the present year is $4,401,695, as compared with $6,087,526, decrease $1,685,831. Records of the seventeen western cities show a decrease of $1,133,953 for February and a decrease of $3,114,627 for the two months period, the comparative figures being $1,397,806 for February of the present year, against $2,531,759 in the corresponding period in 1913. The figures for the two months period are $2,427,516 for 1914, as against $5,542,143 in the corresponding two months last year. Most of the larger cities, both in the east and in the west, record a falling off from last year's figures. This, however, need not be taken as a criterion, for though permits were lower there is every indication that a great deal of construction work will shortly be undertaken. Present indications point to the fact that building will be more or less confined to the smaller type of house in order to meet the great demand for accommodation. In Montreal the total value of permits for the two months of this year shows a reduction of $200,597 on last year's total for the corresponding period. In view of the number of building plans that were passed during the last two months of 1913 it is scarcely surprising that a falling off in the value of permits had to be recorded during the first weeks of this year. The city of Maisonneuve, however, shows a substantial advance during February.

Regarding Toronto, the majority of the 453 buildings for which plans were endorsed during February, were small brick dwellings ranging in value from $1,500 to $3,000. Among the larger permits the most important were a brick warehouse to be erected at the corner of Richmond and Duncan Streets at a cost of $75,000, a $60,000 lodging house on Sherbourne near Carlton, and a factory on Hayter Street. March permits to date include a large factory on Adelaide Street West at a cost of $40,000, and a brick block at the corner of Morley Avenue. Like most of the other cities, Toronto reports a reduction in the number of permits issued the first two months of the present year as compared with the corresponding period in the previous year. The decrease for February was $395,995 and for the two months $776,684.

Building prospects at St. John, N.B., appear to be very good, though there was a decrease of $587,400 over the first two months of 1913 and a decrease of $88,300 in the returns for February, 1914, as compared with the previous year. As has already been announced in our columns, construction work on the sugar refinery and the new Post Office will be resumed, and the great harbor works at east and west St. John will be proceeded with as soon as the weather permits. It is doubtful whether work will be commenced this year upon the two new wharves, to be built by the Government at an estimated cost approaching a million dollars. Apart from this, however, there will be a much larger expenditure on harbor works this year at St. John, than in any previous year. Builders in London, Ont., are looking forward to a very busy season, the value of permits issued in the last-named city almost doubling those issued in the same period of 1913. If permits continue to show an equal growth the present year will probably surpass all records. The total value of permits issued for the two months of 1914 were $73,270, against 36,855, being an increase of $36,415. Higher building figures for February are recorded in several localities, Hamilton permits, valued at $163,100; St. Catharines, $38,450, and Windsor, $55,825, being the most prominent. In the western provinces so far as the records show the amount of constructional work in contemplation is below what it was twelve months ago, with the exception, perhaps, of the cities of Winnipeg and Medicine Hat.

Regarding Winnipeg, the prospects for the present year are exceedingly bright. To the end of February permits totalled $259,600 more than for the corresponding period last year. There appears every indication that this pace will be maintained during the year. Plans are being prepared by one architect for 10 apartment blocks, each to cost not less than $50,000 and a number of these buildings are certain to be commenced this year. In Medicine Hat the record shows an increase of $8,925 over the month of February, 1913, though a decrease of $7,105 is recorded for the first two months as against the corresponding date last year. One of the leading firms has announced an extensive building programme in view for the coming season.

At Vancouver, 239 permits have been issued for January and February, representing $473,593 in value, the total for the month of February being 127 permits valued at $262,076, as against $1,045,204 in February, 1913. The record, generally speaking, shows a decrease in 23 cities and an increase in 15 cities. The average decline during February in Eastern Canada was 21.4 per cent., in the West 44.3 per cent., and in 41 cities 31.7 per cent.

Why are Architects Estimates Always Low?

ONE of the striking differences between theory and practice is brought out in the matter of preliminary estimates furnished by architects on the plans they make. Perhaps it is not always the case that they under-estimate their plans, but it happens so many times that it has become a by-word among builders, and no contractor would agree to put up a building on the architect's estimate without figuring it for himself or taking some other builder's figures for it.

It may be that one of the reasons is really an unconscious one, and arises from a wish to make a desirable thing look reasonable in price to the prospective builder. If the architect goes too high, the party may not build at all, or he may try elsewhere for a more economical plan, so the preliminary estimate is based as nearly as possible on the prices of material available to the architect, and perhaps the price of labor on some similar building already erected. The estimator may not intentionally go lower than he thinks the work should be done, but he forgets that what really interests the owner is the price for which he can contract the job complete.

Sometimes architects ask for preliminary estimates from their friends in the various branches of contracting or manufacture, but very few concerns are willing to make up these estimates just as a favor to the architect, and he is really thrown upon his own resources for his costs, as he should be. However, an architect (and every architect who furnishes preliminary estimates) should get into closer touch with the methods of figuring practiced by general contractors. He should take notice of the several things given a money value by the contractor and which the architect is prone to ignore altogether.

The general contractor must figure his office work, whether he maintains a down-town office or whether he does the work himself at his own home; he is at some expense for superintendence, besides the cost of a working foreman; he must spend sums for railroad fare and car fare; he is at expense for correspondence, telephone and telegraph; he must pay freight and drayage; he must make good the mistakes of his own men, and also those of the sub-contractors, if they are not in a position to be held responsible for their work. Of course, he should not buy of such concerns, but some good people get into trouble after they make contracts, and before they are completed their responsibility has to be assumed by the general contractor.

Another thing which the architect often loses sight of is the amount general contractors figure as a profit or margin for doing business. If one figures the cost of a job by adding up the items with prices at the various sources of supply, he is bound to be short, and away short. For instance, an item just lately brought to mind was that of a clock system bought for a large high school building. Of course, the architect was able to tell the school board what the system required would cost, as he had the price from the manufacturer. It would be installed by some local plumber, as there were sundry pipes, wires and conduits to put in place. The plumber's bill, when the work was installed, was $1,200, and this was an item which did not enter into the estimate for the cost of the clock system. If this had been included in the work of the general contractor, he would have found out beforehand about the price of putting it in, and the discrepancy between the architect's estimate and the contractor's bid would have been that much greater.

There are two evils to the building business resulting from low preliminary estimates, and while they are not worthy the consideration of men who make a business of building, still the very fact that they arise unconsciously in the minds of the prospective builders makes them important to all parties concerned. The evils referred to are, first, the idea that the contractors are trying to get exorbitant prices for the work required, and, second, that the architect has purposely made the estimate low, so that the builder would go ahead and make his arrangements for building. Both of these ideas are unfortunate because they are both untrue and because they both might be prevented. The same thing holds in regard to the subcontracts, if the architect gives the patron a figure on them separately.

How much better would the feeling be if the estimates furnished by the architect would a little more than cover the completed buildings they design. It would often mean relief from real financial embarassment for the builder who makes his arrangements for capital before he lets his contracts. It would put the face of goodwill and honesty upon all parties interested, and that is where it should be in all legitimate business.

It must be borne in mind that it is no mean job for an architect to make up a reliable preliminary estimate without the aid of the men who do the work of sub-contracting. Very few general contractors figure the sub-contract work themselves, but get the bids of the various sub-contractors first hand, and from them and such other expense as will occur make up their bids on the whole building. The easiest way to arrive at something like a reliable figure is for the architect to compile a reference list of buildings and their actual cost for completion, and if he is diligent enough in this, he can, in time, match up the cost on just about anything he is liable to turn out himself

There are some men who make a business of making preliminary estimates, but few architects like to go to this extra expense when the building itself is more or less problematical. If they could show the prospective builder the picture of a building, a sketch of its floor plans and verbal description of its interior, with a statement of what it would cost complete, he would convey a better idea and at the same time relieve himself of a great deal of annoying and unprofitable work.

After the plans are approved and out for bids, then all the sub-contractors who are going to figure them get busy and do their several parts of figuring and turn the figures in to the general contractors who intend to bid on the work. If the architect could get these figures he would be in clover, but if he should get them on a preliminary estimate, the owner might conclude that he must cut it down $10,000 and that would cause the whole thing to be figured over again. Every concern in the building material business knows that it costs good money to make estimates, and unless it will give them some kind of advantage or preference they will not figure until the work is ready for the bids of the general contractors.

As a preliminary to foundation work in a new hydro-electric scheme near Augusta, Me., test holes were drilled to determine the character of the granite ledge on which the dam was to be built. To determine the extent of seams in the rock dye was forced in under pressure, the colour showing wherever there was a flaw in the stone. This method proved very satisfactory in that the character of the ledge was known in advance, and this prevented unnecessary drilling and excavation. The tests disclosed the presence of several dangerous, smooth, horizontal seams, to which it was necessary to excavate the ledge in order to prevent possible uplift and sliding of the dam. These test holes, as well as any other holes where necessary, were grouted under 100 lb. air pressure before construction commenced. In addition, to prevent possible sliding, trenches were cut in the ledge. It is believed that by these methods a very secure foundation was obtained at a minimum cost.

Contractors and Conservation

Contributed by R. O. Sweezey, C. E., Montreal

VIRTUALLY unknown a few years ago, the alluring word "conservation," which in this country conjures up pictures of vast forests, water powers and other great resources of nature, has now become synonymous with progressive national development.

The vigorous campaign of enlightenment instituted a comparatively short time ago with a view to educating and arousing the public to a realization of its duties towards posterity has so successfully gripped the minds of intelligent people that everywhere CONSERVATION is the keynote to the administration of natural resources.

Well does the writer recall many scenes of forests, which had taken over a century to grow, destroyed in a few hours—the result of gross negligence and profligacy of those who, on duty or pleasure bent, would travel through the wilds of the country with never a thought to extinguish a camp fire, leaving, in consequence, devastation and black desolation in their wake. Nor until recently were the railroads less to blame for similar destruction. Therefore it is gratifying to observe the wholesome effect of an awakened intelligence in those whose business or pleasure takes them into the wilds. Nowadays, in travelling by canoe and trail through Canada's hinterland, everywhere—with but one general exception—there are evidences of caution in the selection of camp grounds and fire places by the tourist or bushwhacker, while there is also manifest further care in extinguishing fire before breaking camp, so that abandoned and smouldering fires, testifying to the proximity of the tenderfoot, are now indeed rare sights.

The one general exception to the evidences of responsible care with fire in the woods is found wherever railroad construction camps have penetrated into the forests. Carelessness with fire, resulting in wanton destruction of the most exasperating nature, seems everywhere to attend the operations of railroad contractors in Canada's backwoods. This horrible menace lurking in the best forests of the land, in spite of all that has been said and done to emphasize the gravity of bush fires, is more real, and more calamitous in effect, than all the other enemies of the forest combined.

Employing, perforce, the most ignorant and indolent types of foreigner laborers, who are often under the command of a burly, wooden-headed type of foreman, it is not surprising that railroad contractors have become such dangerous enemies of the forest. These laborers, many of them recruited from the lowest ranks of ignorance, think nothing of setting fire, in a dry period, to the inflammable bark of a giant birch, merely to witness the effect. Fires for lunching purposes, for smudging flies, or for idle "cussedness," are never extinguished by such dough-heads but are left for a chance breeze to flame them into miles of burning timber. Nor, as a rule, do they exhibit any concern when disaster attends such criminal actions, remaining more often in blissful ignorance of the fact that it was their carelessness which caused the disaster. As for the construction bosses and foremen, they will concern themselves actively enough to save if possible their camp outfit and supplies, but they remain as a rule totally insensible to their duty in preventing the recurrence of such irreparable losses.

Is it any wonder that Dr. Fernow, after his rapid examination, a couple of years ago, of the forests along the line of the Transcontinental Railway in Northern Ontario, presented a report full of pessimism regarding the quantity of timber there? How could he report otherwise when the builders of the railway had been busily destroying the timber for several years?

Therefore it is among railway contractors and the class of laboring men they employ that the educative force of conservationists should be directed.

The offences of the railway contractors date back to the days of C. P. R. construction when they destroyed thousands of square miles of virgin timber north of the Great Lakes. These contractors must come to a realization of their responsibilities and abandon such reckless methods. As laws are now enacted aiming to make railroads responsible for forest protection so should measures no less stringent be enforced against the contractors, who—though they would deny it—as a class are negligent and dangerous to an alarming extent as regards bush fires. Several years of experience in the hinterlands of New Brunswick, Quebec, Ontario and Western Canada have furnished the writer innumerable proofs of these conditions. And now we must awaken to the fact that this menace is not past history but is every year being transformed into real and disastrous losses.

The Spring is now upon us and conditions will soon be ripe for a recurrence of the disasters which I have illustrated.

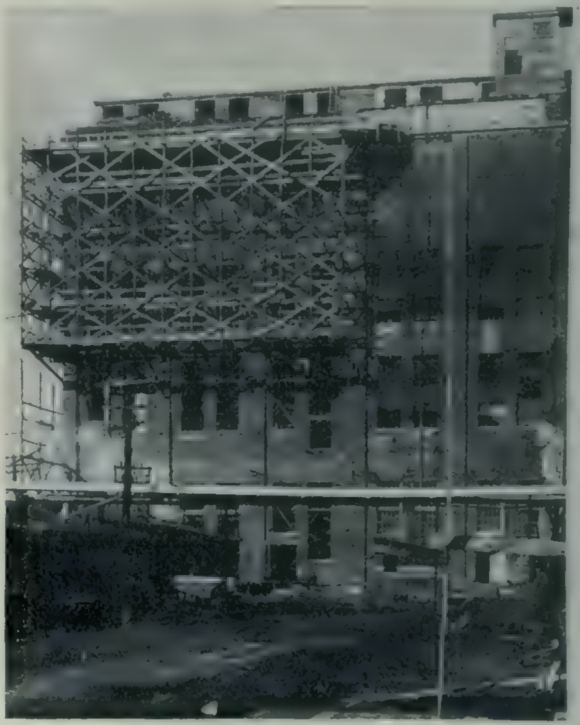
The comparatively rugged region of the St. Maurice River, with the thin sandy soil which overlies its Archean formation, provides conditions eminently favorable to disastrous results in case of bush fires. A very large area around the head waters of the St. Maurice, which was burnt over many years ago, is now but little reforested, presenting hundreds of square miles of desolation. This burnt area comprises the greater portion of the watershed above the point where the large storage dam is shortly to be built by the government of Quebec, at a cost of over one and a half millions of dollars. A word of caution might not be out of place here, for as the idea of this proposed storage is itself a child of conservation, in the carrying out of which 500,000 horse-power will be added to the falls of the St. Maurice, it is permissible to say something of the country which lies between the proposed dam site, some ten miles below the old H. B. Company's Post of Kikendatch and the Transcontinental railway.

To fetch in the materials and supplies for the building of this dam either a railroad or a team road will be built during the coming summer through a distance of 45 miles from the T. C. R. to the dam site. This road will traverse a fairly well-wooded portion of country, but unless prompt and proper measures are taken for fire protection it will be safe wagering that it will be a sorry looking country by the time that the road is completed.

CONSERVATION! May we never let up the cry until every man, woman and child from the Atlantic to the Pacific shall have grasped the full significance of it! And then, lest we forget it, may we keep on repeating it!

An Expeditious Contract at Hawkesbury

BELOW we illustrate a contract carried out by A. F. Byers & Company, Limited, Montreal, at Hawkesbury, Ont., for the Riordon Pulp and Paper Company. The latter concern have a sulphite fibre plant at Hawkesbury, and the contract was for the construction of an addition to their digester and blow pit buildings. The work was divided into two parts—the digester building and the blow pits, these being separated by the blow pit chamber. The digester structure was 32 ft. x 62 ft., and was four floors high, the top one containing the chip bins. It was built of structural steel, with brick walls, a pure cement mortar being used. The bricks were laid in English bond throughout, grouted every fourth course. The vomit pipes, for carrying off gases from the blow pits, were bolted to the outside walls of the digester building and were constructed of pitch pine.



Building for digesters, Riordon Pulp and Paper Company's plant, Hawkesbury, Ont.

The pits were 50 ft. x 60 ft. and 21 ft. high; they were three in number, each 17 ft. 2 in. wide, and lined throughout with pitch pine, which was held in place by wooden dowels, no nails being used in any of the wood work throughout the building. The pits were constructed of heavily reinforced concrete, with a structure of steel columns and angle tie rods.

The work was done by means of a Beatty hoisting engine and Smith mixer, the concrete being hoisted on the same elevator as the bricks.

The contract price was $50,000. The scaffolding cost $531 or a dollar and sixty cents per 1000 bricks used.

The time allowed for the work was 90 days, and the firm completed it according to contract,

---

Mexico, which can boast of some wonderfully fine churches, also claims the smallest church in the world. It is situated at Penon, near the city of Mexico, and has a "seating capacity" of about ten, although there are no seats.

Methods Employed in Strengthening an Old Factory Building

An Interesting Engineering Problem the Solution of Which was Found to be the Construction of Eight Monolithic Reinforced Concrete Flying Buttresses Built from Bed Rock to Roof

PILLSBURY "A" Mill, in Minneapolis, Minn., has recently been repaired to such an extent that it has been entirely rebuilt, with the exception of the walls. These latter, however, have been so strengthened as to be more solid than ever, and this, too, without stopping the mill or materially reducing its output. The wooden posts and girders were so weakened by dry rot and the walls so badly shaken by the vibration of heavy machinery, that they were badly cracked and about twenty-two inches out of plumb.

About twelve years ago Mr. J. H. Miller became alarmed at the condition of the wooden posts and girders and on his recommendation a series of four posts lengthwise and crosswise were erected through the centre of the mill. They were made up from I-beams and channels in the machine shop of the mill and erected by mill employees, the conditions not permitting any uniformity of length or even of design. No outside structural firm could do the work as advantageously as the mill company itself. As there was some criticism of this work, Mr. C. A. P. Turner was called in as engineer to examine it and report to the management. His only criticism was that the work which was complete up to the third floor at that time, was perhaps a little stronger than necessary.

At his suggestion, Bethlehem "H" sections were adopted for the remaining columns. He also advised the use of vertical diagonal braces to stay the mill laterally, but because of the room these would require and the shifting of machinery necessary to accommodate them, this advice was not heeded. The substitution of steel for wooden posts and girders was carried on until the company went into the hands of receivers for reorganization, and nothing was done for several years.

After the reorganization, Mr. Max Lehman was made superintendent of the mills and this work was again started. The vibration of the mill became alarming and both the north and south walls were badly cracked near the corners of the building; the floors seem to have acted as horizontal trusses and to have transmitted the stress to the end walls. Several diagonal braces of 12 in. x 12 in. timber were put in as a temporary expedient, and in January, 1913, Mr. Turner was called upon to devise something to take the place of the diagonal bracing which he had proposed. Having ascertained that the eastward sag of the building was not due to any settlement of the foundation he concluded that if the east wall was firmly held in position, steel struts could be run from wall to wall between the joists of each floor to hold the west wall from falling in, this wall having nothing to carry but its own weight and one end of the joists of the west panels. Mr. Turner recommended that monolithic reinforced buttresses be built outside the east wall and that the replacement of wood with steel be extended to include the whole interior construction. This being approved by Mr. Wm. DeLabarre, engineer for the Minneapolis Mill Company representing the Water Power interests of the Pillsbury Flour Mills Company, the scheme was adopted and carried out. The interior steel work was done by mill employees under the direction of Mr. Wm. Quayle, head millwright, and the concrete work both outside and inside by Messrs. H. N. Leighton & Company, contractors, Mr. F. A. Camp superintending it as an assistant to Mr. C. A. P. Turner.

The building is about 170 ft. x 108 ft., six storeys and basement in the main part with a cupola about 48 ft. x 108 ft. above the main roof, constituting a seventh floor. The total height from basement floor to cupola roof is 127 ft. 6 in. There are 60 columns arranged in six rows of ten each dividing the floor space into panels about 15 ft. 6 in. square and extending from basement floor to main roof. They are tied together by two lines of 12 in. I-beams lengthwise and either two lines of 10 in. I's or four lines of 10 in. channels crosswise at each floor. These extend to the wall and are anchored thereto. The 12 in. longitudinal I-beams are supported on brackets rivetted to the columns and carry the floor joists. The transverse 10 in. I-beams and channels carry no loads. The former are fastened to the flanges of the vertical channels of the built-up columns with 3 in. x 5 in. angles rivetted to their webs. At the "H" section columns the 10 in. channels are placed one on each side of the flanges, bevelled washers to fit the flanges interposed on one side, and rivetted through both channels and the flanges. Under all floors except the third, where there is an offset in the walls, a line of 15 in. channels is rivetted to the underside of the transverse struts about four inches from the wall. Starting on the offset, a reinforced concrete lining varying from four to seven inches in thickness on account of irregularity, was

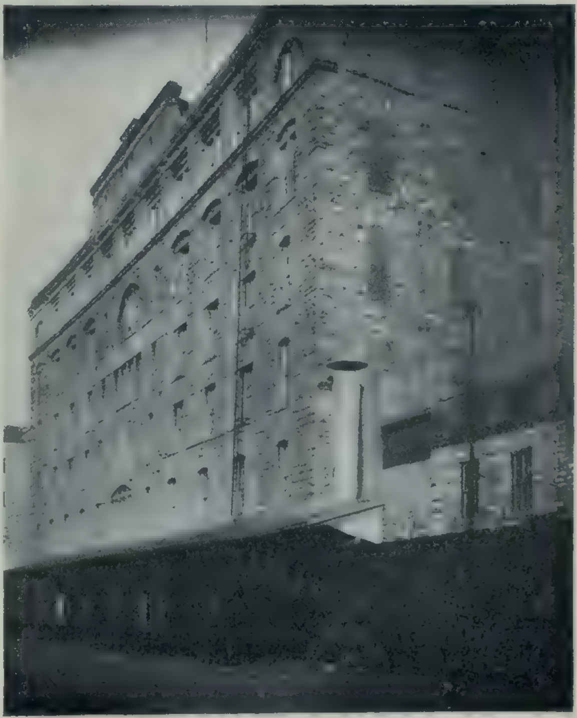


Fig. 1.—Exterior of building.

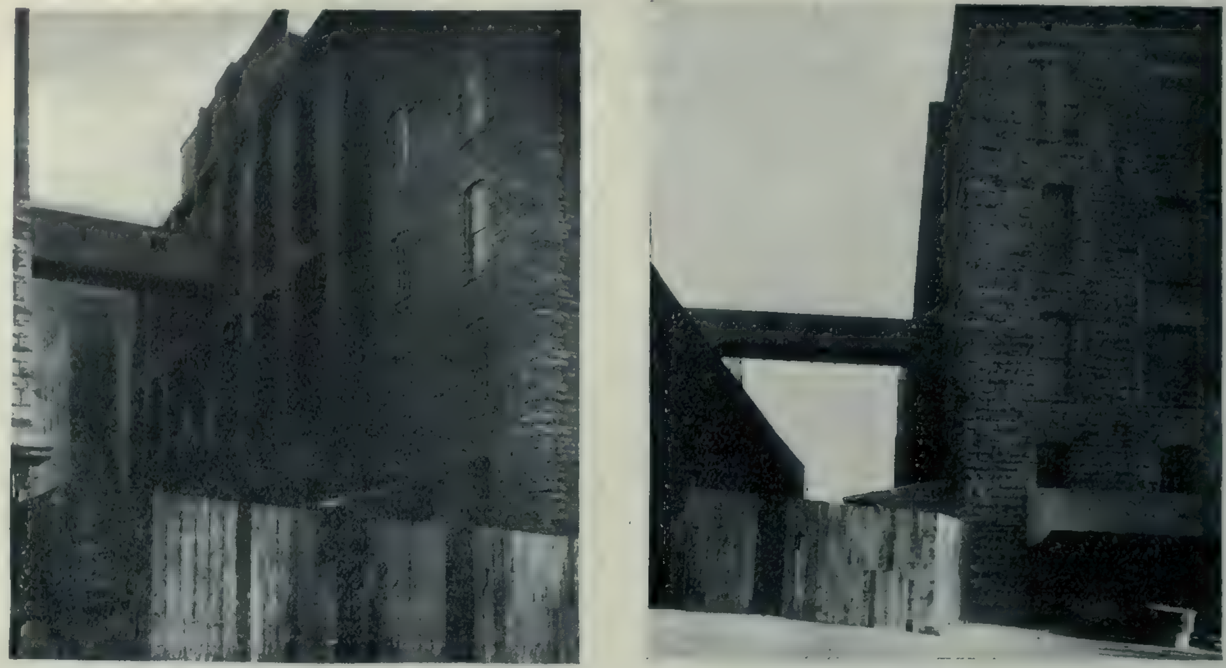


Fig. 2 Fig. 3
Monolithic reinforced concrete flying buttresses employed to strengthen the Pillsbury mill.

made to the east and west walls up to the roof and was extended a short distance on the north and south walls where they were badly cracked. The old plastering was entirely removed and the joints dug out as deep as possible with narrow chisels. The reinforcement was in general of ⅜-in. rounds spaced 12-in. centres horizontally and vertically, but ⅝-in. rounds were added to the verticals at the window jambs. New window frames with openings somewhat smaller than the old ones, were provided and the concrete continued around the jamb corners to the faces of these frames. The jambs were reinforced with number eight wire, four-inch mesh, hog netting, which was turned around the corners and extended about a foot parallel to the walls. This concrete backing binds the cracked walls into a monolithic mass, which is stronger than the walls were when new.

In the original timber construction the outer ends of the joists were carried on trimmers over some of the windows. These were removed and the joists allowed to rest on the 15-in. channels before mentioned, which in this storey were supported by the addition to the concrete lining of a 15-in. projection similar in section and reinforcement to half a "Mushroom" column head.

From the engineering standpoint, however, the main feature of the whole scheme, without which all the above described work would be useless, is the eight monolithic reinforced concrete flying buttresses (shown in Figs. 2 and 3) built from the bed rock 34 ft. below the tracks to the roof. These are located in the line of the transverse rows of columns excepting the two rows nearest the end walls, the transverse I-beams and channels extending through the east wall and being anchored into them. The two middle ones are 28-in. x 30-in. at the main roof level and 3-ft. x 9-ft. at a point 2-ft. above the tracks. The others are somewhat larger at the top as the faces are in a straight line and the wall is bulged out in the middle.

Because of a line of shafting and other machinery in the area (Fig. 4) and sewer and water pipes underneath, it was not possible to place them against the walls any further down than about two feet below the tracks. At this height they spring from the wall in a parabolic curve which brings the inside 6-ft. from the wall in a drop of 12-ft. From this height down to bed rock the inner face is vertical. About two feet above the tracks the batter of the outer face is increased to "one to one" for three feet in height to meet a timber track stringer and leave the necessary clearance at the height of a car floor. Below this the batter is 3½-in. per foot. On the bed rock the deepest buttress is 3-ft. x 15-ft. and its outer face 21-ft. from the face of the wall. The buttresses are connected together by concrete beams 18-in. x 30-in. at the second and fourth floor levels, these being close to the outer face and joined to buttresses by brackets above and below, making a total height of 6 feet and 6 in. on the side faces. They are reinforced horizontally with 8-1-in. rounds in ⅜-in. stirrups which are spaced about 15 in. centres. Each bracket has 2 1-in. rounds extending past the centres of beams and buttresses. At the main roof level is a beam 20-in. high and from 30 to 36-in. wide, its face being straight and its back fitting the wall, reinforced with 18-⅝-in. rounds, six near the top and six near the bottom throughout, the outer six being raised over the buttresses and depressed between them, stirrups being ⅜-in. round and about 15-in. centre.

The buttresses are reinforced vertically with 6 1⅛-in. rounds in a spiral of ⅜-in. round, 23-in. in diameter, 4-in. pitch, placed near the outer face and inclining with it. Near each side face of the buttresses are ⅜-in. rounds spaced 8-in. horizontally and 12-in. vertically. It was intended that these horizontal rods should extend into the stone wall, but as it was found difficult to maintain even spaces they were bent up or down at the ends and an equal number of ⅜-in. rounds 24-in. long were driven as far as possible into the joints of the stone work. The joints were all cut out

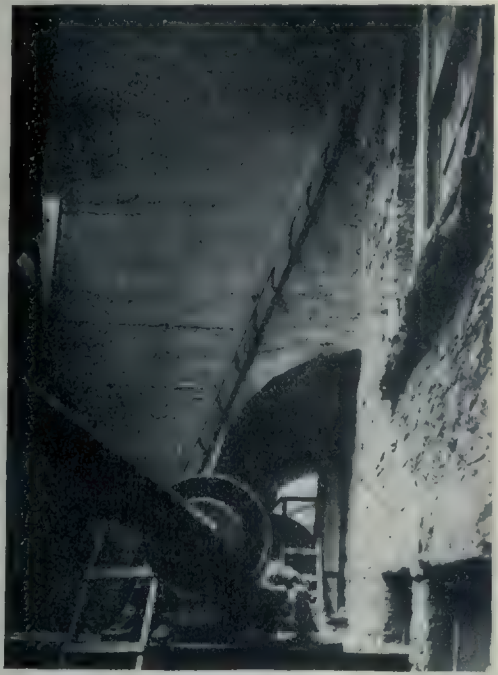


Fig. 4.—Shafting, etc., in area.

as deep as possible with narrow chisels, that the concrete might flow into them, thus obtaining a firm bond, the absolute rigidity of the joints between buttresses and wall being the vital feature of the whole scheme.

In the writer's opinion these buttresses if built of ordinary masonry could not have been made sufficiently rigid to accomplish the desired end, and in the opinion of some engineers even the monolithic ones would not do it, but "when this work was completed," to quote from a letter from Superintendent Lehman, "the vibration of the mill practically stopped. The total cost was approximately $150,000, but the mill was not shut down a single day." The cost of the interior steel work was about $120,000 and of the concrete work about $30,000.

The relative economy of using sand or concrete as a base for brick pavements was discussed at some length by Mr. Robert Hoffman, chief engineer of the Department of Public Service of Cleveland, Ohio, before the American Association for the Advancement of Science. After going exhaustively into data on cost and length of life, he draws the conclusion that an unyielding sub-base, such as concrete affords, is highly desirable, and should be supplied wherever possible, and in most cases will prove more satisfactory, even at slightly greater cost. Concrete will carry the pavement load over the many soft places caused by street openings prior to paving and will prove a greater factor of safety against settlements and irregularities liable to occur where no concrete is employed. Any settlement in a pavement foundation breaks the bond of the brick and will be rapidly followed by serious deterioration. Another possible economy in supplying a concrete foundation may be found in the possibility that some time it may be desired to replace brick with other kinds of paving material for which a concrete foundation must be supplied, such as wood block, asphalt or asphaltic concrete, in which event the cost will be materially lessened by reason of the existing concrete. In open country, with poor drainage facilities, there is no doubt, he says, that the damaging effect of frost and the yielding subsoil would soon depreciate any brick pavement with only a natural soil foundation, and under such conditions concrete is the only safe and economical foundation to use.

Rapid Foundation Work

A most interesting example of the use of hollow steel piles for rapid deep foundation work is found in connection with an operation lately conducted in West 28th street, New York City, and described by Building Age. Rock was located 38 feet below the curb and the material above it was clay and water-bearing sand. The structural steel was due in three weeks but the completion of the cellar being still ten days away the steel pile foundation method appeared to offer the only solution of the problem. Specifications were drawn which called for 85 12-in. steel piles driven to rock, blown clean by compressed air and filled with concrete reinforced with 2-in. rods.

Notwithstanding various obstructions on the ground, the shoring of adjoining buildings, etc., the driving was started on the last day of the month. The excavator was still taking out his runway while the rear half of the lot was completely driven. After he had left the ground a compressor was set up and the first pipe was blown on the 7th of the following month. Three days later all driving and cleaning had been completed and during the following two days all the piles were filled and capped, so that the entire foundation was completed several days before the expected arrival of the steel.

In another instance, where the contract called for the work to be completed in three months, the actual time required was exactly a month and a half, during which time all the excavation had been done, including sheeting, shoring, pile driving, mounting of concrete girders to carry the wall and capping of the piles ready to receive the grillage.

In this connection it may not be without interest to mention that the hollow steel piles are employed in clusters to support a building and are driven in the usual method. The steel pile sections vary in length from 20 ft. to 22 ft. and in diameter from 12 in. to 24 in. If the ground is to be penetrated to a depth greater than 22 feet the sections of piling are connected by means of a sleeve in such a manner that a watertight joint is formed. A jet of compressed air under a pressure of 150 lbs. to the square inch is then employed to blow out the earth and water contained in the shell. When this has been done the exposed rock can be examined by lowering an electric light.

After the piles in each pier have been cleaned out they are cut off at exactly the same height, a task that is exceedingly difficult when there is little room to operate. For the cutting process the oxy-acetylene torch was used. The hollow shell was next filled with concrete reinforced by 2-in. steel rods 50 ft. in length.

An idea of the carrying capacity of one of these piles may be gathered from the statement that on a single 12-in. steel pile 100 tons can be safely maintained. Piers containing 16 piles have been used and holding up to 1,300 tons are not unusual.

Rapidity of building construction is of such great importance that the method of first making an open excavation to rock bottom in providing a foundation has been displaced very much by the system here described.

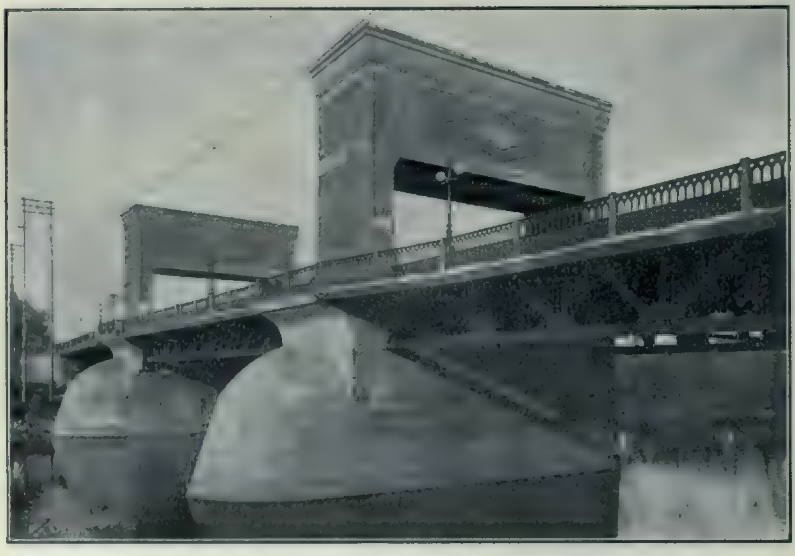
The Highway Bascule Bridges of the City of Winnipeg

Specially contributed by H. A. Mackay[*]

OSBORNE STREET BRIDGE

IN the building of its bridges over the different river and railway crossings, the city of Winnipeg in the past never looked far enough ahead. All the bridges were built wide enough only for the needs at the time of erection. The fact, however, that this was so may not be due to want of foresight, but to the need for building according to the money in hand. In any case the expansion of the city has exceeded the wildest dreams of the most optimistic. The result is that the city of Winnipeg is now incapable of handling with expedition the vehicular and street car traffic over its bridges. Delays are a frequent occurrence—either the street cars waiting for the vehicular traffic, or vice versa, with the attendant loss of temper to the various persons concerned. This condition is especially accentuated in connection with the bridges over the Assiniboine River, serving Fort Rouge and the rest of the city lying south of the river. This district has been built up very rapidly within the last few years, and as a result of the increased settlement the traffic has increased, but only within the last year or two has anything been done towards relieving the situation.

A comprehensive scheme of bridges across the Assiniboine River, from Main street to the city limits, is an absolute necessity for the city of Winnipeg. A start was made early in 1912 when the contract was let for a new bridge over the Assiniboine River at Osborne street to replace the old one which had become incapable of taking care of the traffic over it. At this point the river is about 300 feet wide, with sloping banks. As the river above this point is navigable, the city was forced to provide a movable span for clear passage of boats. A clear opening of 100 feet was required, and it was decided to use a double leaf Strauss Bascule Lift Bridge. The fixed portion of the bridge consists of two 90 ft. spans on the south side and one 80 ft. span on the north side, making a total over-all length of 423 ft. The trusses of the fixed spans, which are of the half through deck type, are spaced 45 ft. centre to centre, giving a clear width of 41 ft. between curbs. The street car tracks are placed 12 ft. centre to centre in the middle of the roadway, leaving a space of over 12 ft. each side for vehicular traffic. On the outside of the trusses are placed steel brackets, which carry a 6 ft. sidewalk for foot passengers. The floor is of 3½-in. creosoted wood blocks, resting on 1-in. of sand on reinforced concrete slab. The concrete is reinforced with ⅝-in. square rods. The sidewalk is also of concrete reinforced with ⅜-in. square bars. The handrail on the sidewalk is of ornamental cast iron with reinforced concrete newel posts and "T" bar rolled steel handrail.



The Osborne Street bridge of the City of Winnipeg over the Assiniboine River.

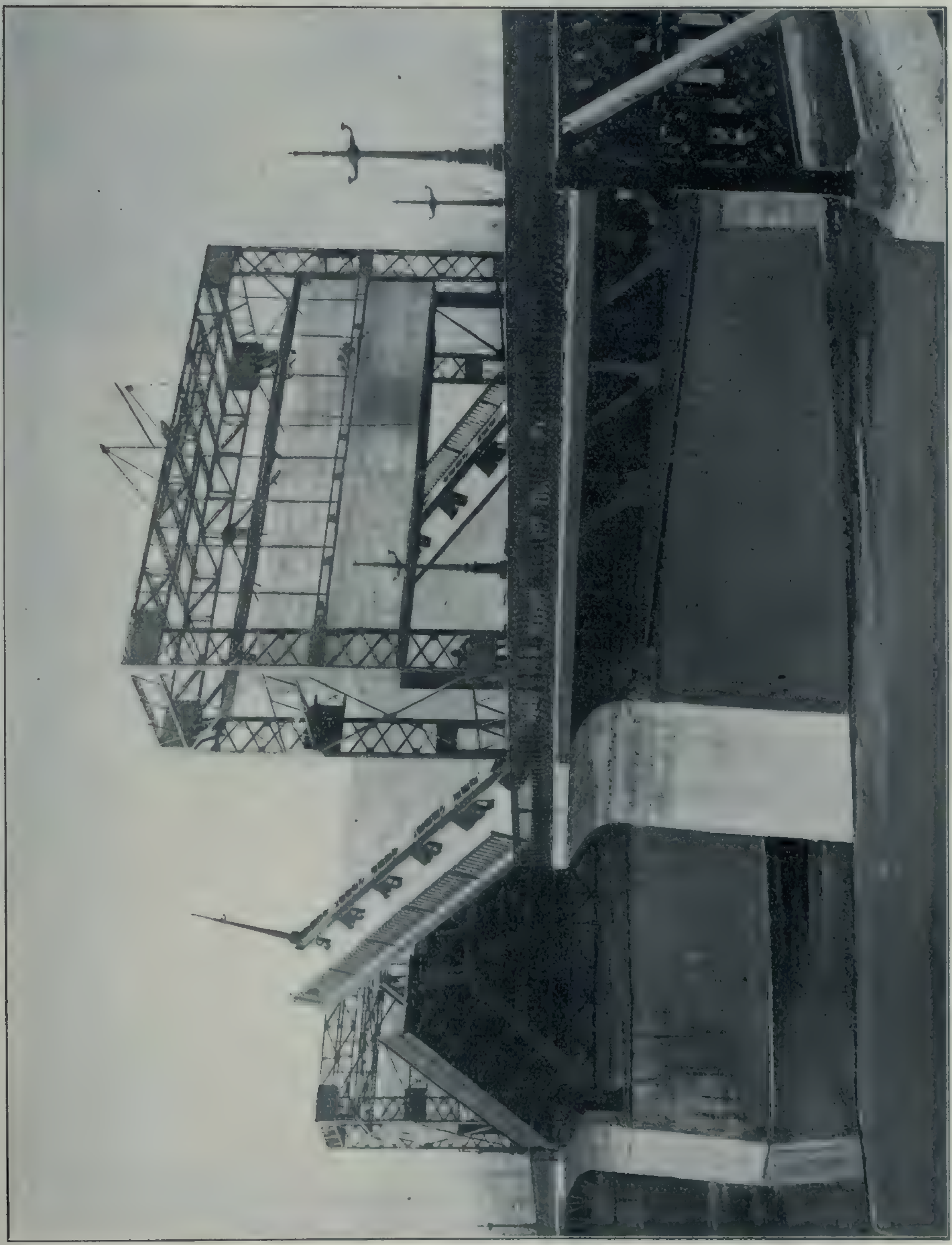
Furnished and erected by the Manitoba Bridge & Iron Works, Limited, under the supervision of Col. Ruttan, City Engineer.

The fixed spans are half deck trusses and are designed to the city of Winnipeg bridge specifications. Typical details of trusses and flood beams are shown. The moving portion is according to the Strauss Bascule Bridge Company's design and is similar to the fixed spans. The counterweight operates at a lever arm of 12 ft., and 240 tons of concrete, 15 tons of steel in the counterweight supports and 17 tons of gravel is necessary to balance each leaf, the accurate adjustment being made by the addition of loose gravel to the adjusting pockets left in the concrete. The pockets were made so that theoretically the bridge would balance when the pockets were half full of gravel, so that material could either be added or taken out as necessary. As it happened, the adjustment required the pockets to be filled almost to the top.

The overhead counterweight and supporting tower were treated as artistically as possible in a utilitarian structure and were covered with concrete plaster on

---

[*] Chief Engineer, Manitoba Bridge & Iron Works, Limited.



Double leaf bascule lift span, Osborne Street, Winnipeg.

St. Andrew's lock lift.

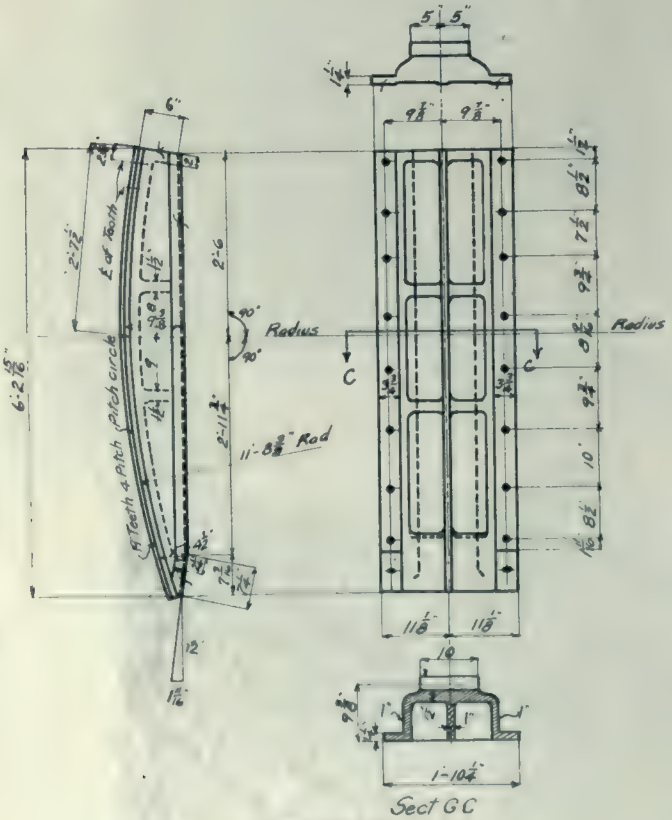
metal lath, giving as pleasing an aspect as possible. The operating mechanism is the usual Strauss design. Power is supplied from hand capstans and transmitted by means of bevel gears, spur gears and pinions to the cast steel racks which are rivetted to the heel of the truss. Should it be necessary to open the bridge quickly at any time, motor power can be applied. In testing it was found that four men can easily open the span. The bridge has been open for a considerable time and has given great satisfaction.

HIGHWAY APPROACHES TO BRIDGE OVER ST. ANDREWS DAM

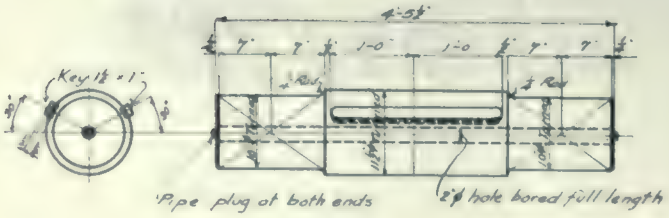
When the St. Andrews Dam on the Red River at Lockport, some twenty miles north of Winnipeg, was built some years ago, all provisions were made on steel work for a highway on top of the dam. During 1913 the necessary approaches were erected on both the east and west sides, and now settlers on both sides have access to one another without requiring to use the slow-moving ferry in summer or to take to the ice in winter.

The east approach is of the ordinary steel trestle type with plate girders, steel floor beams and stringers for supporting the roadway, the longest single span being 59 ft. This approach is on a five per cent. grade and the total length of the steel work is about 240 ft. The clear width of the roadway is 22 ft. The flooring is composed of 4-in. sub-planking, with a 2-in.

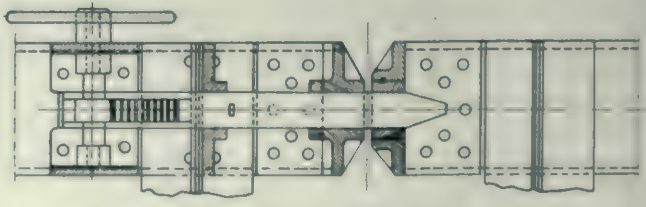
(Description concluded p. 393)



Cast steel rack.

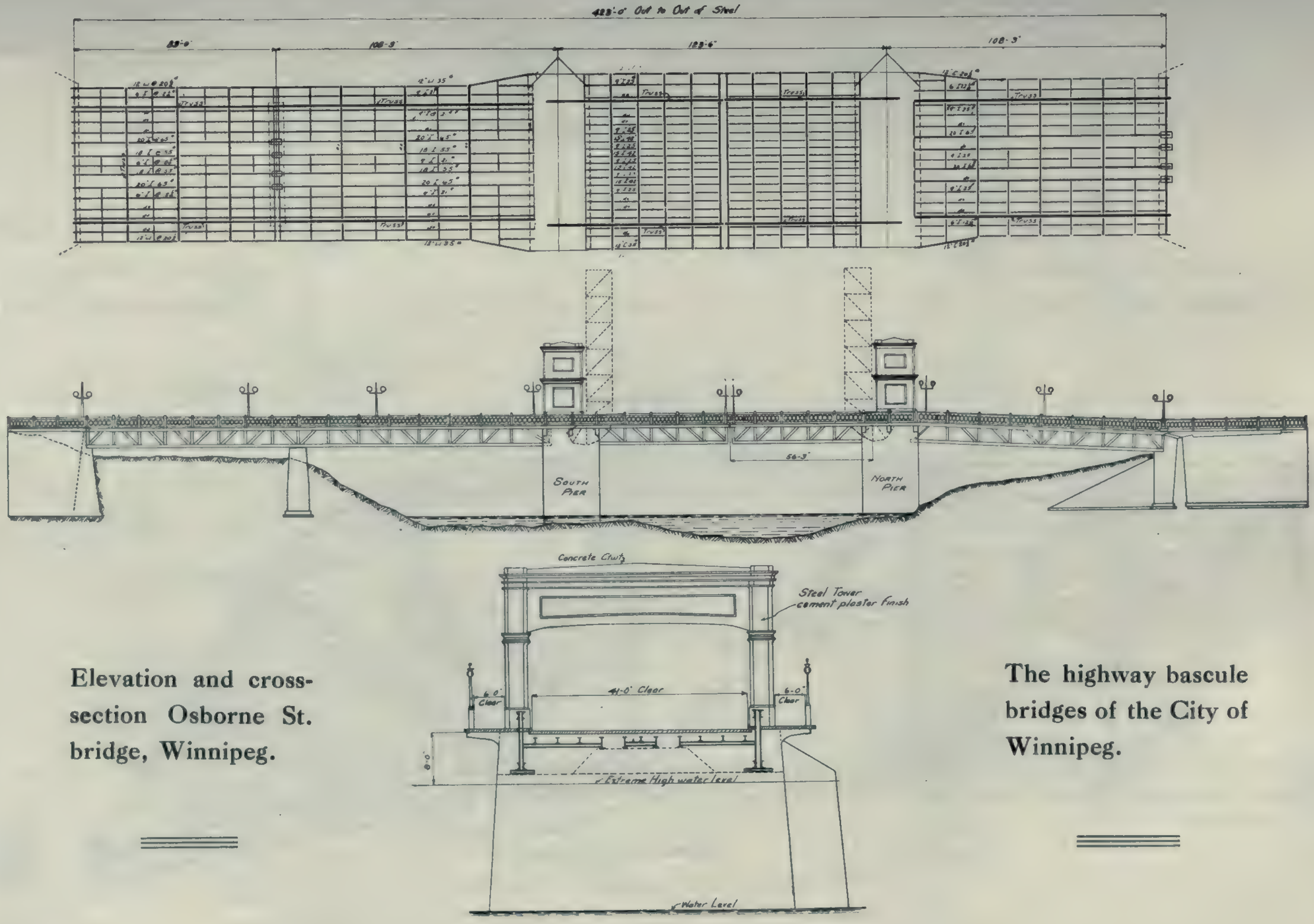


Trunnion



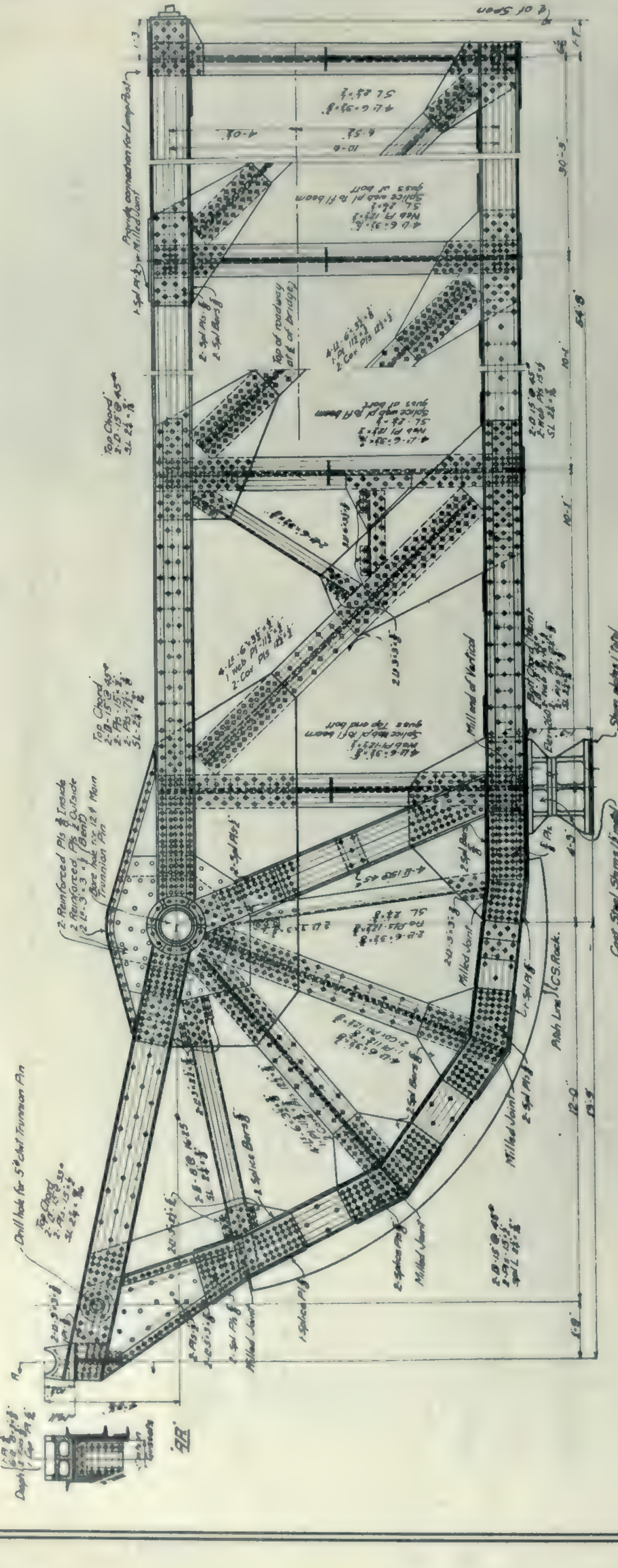
Lock between opening spans.

Details of Parts of Machinery, Osborne Street Bridge, Winnipeg.

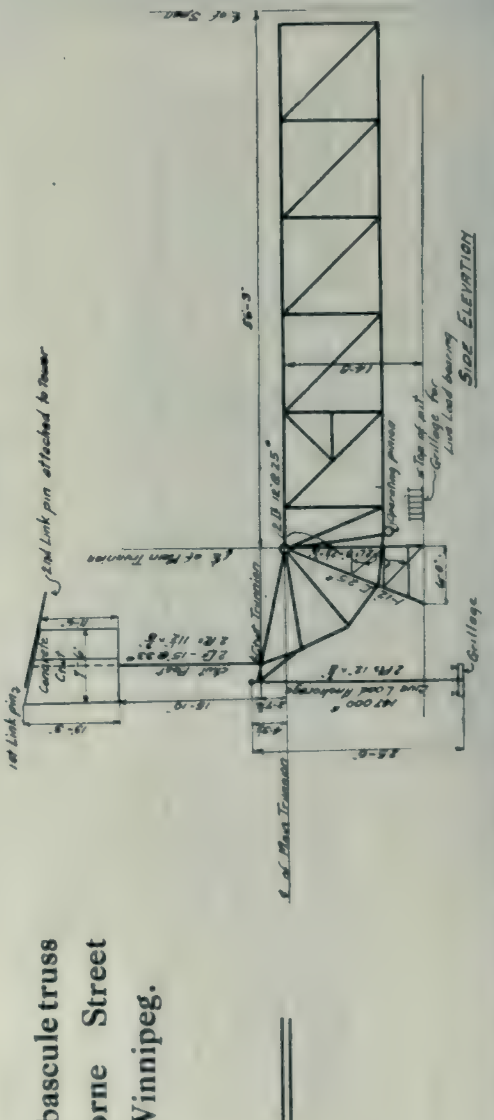


Elevation and cross-section Osborne St. bridge, Winnipeg.

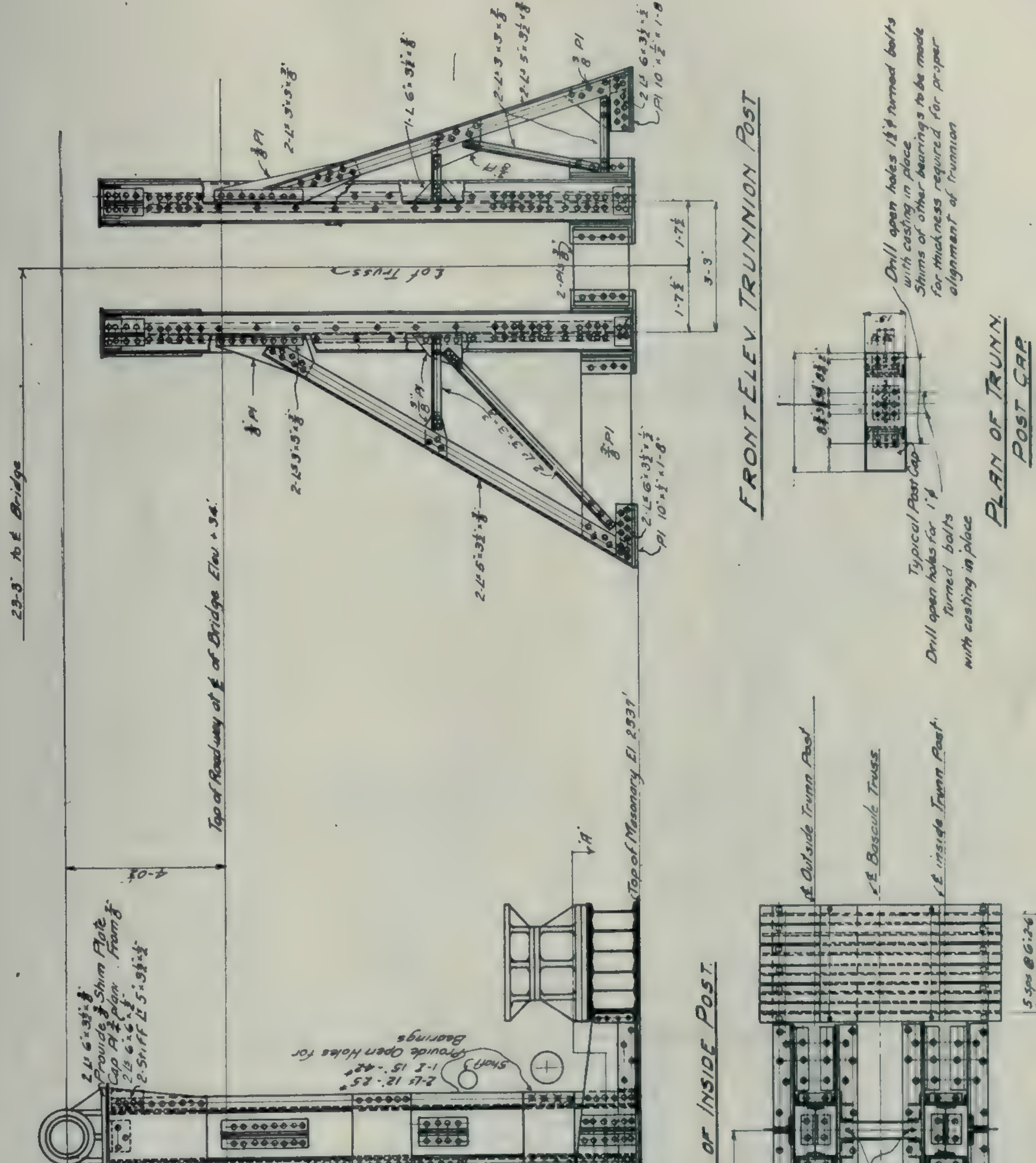
The highway bascule bridges of the City of Winnipeg.



Detail of bascule truss at Osborne Street bridge, Winnipeg.

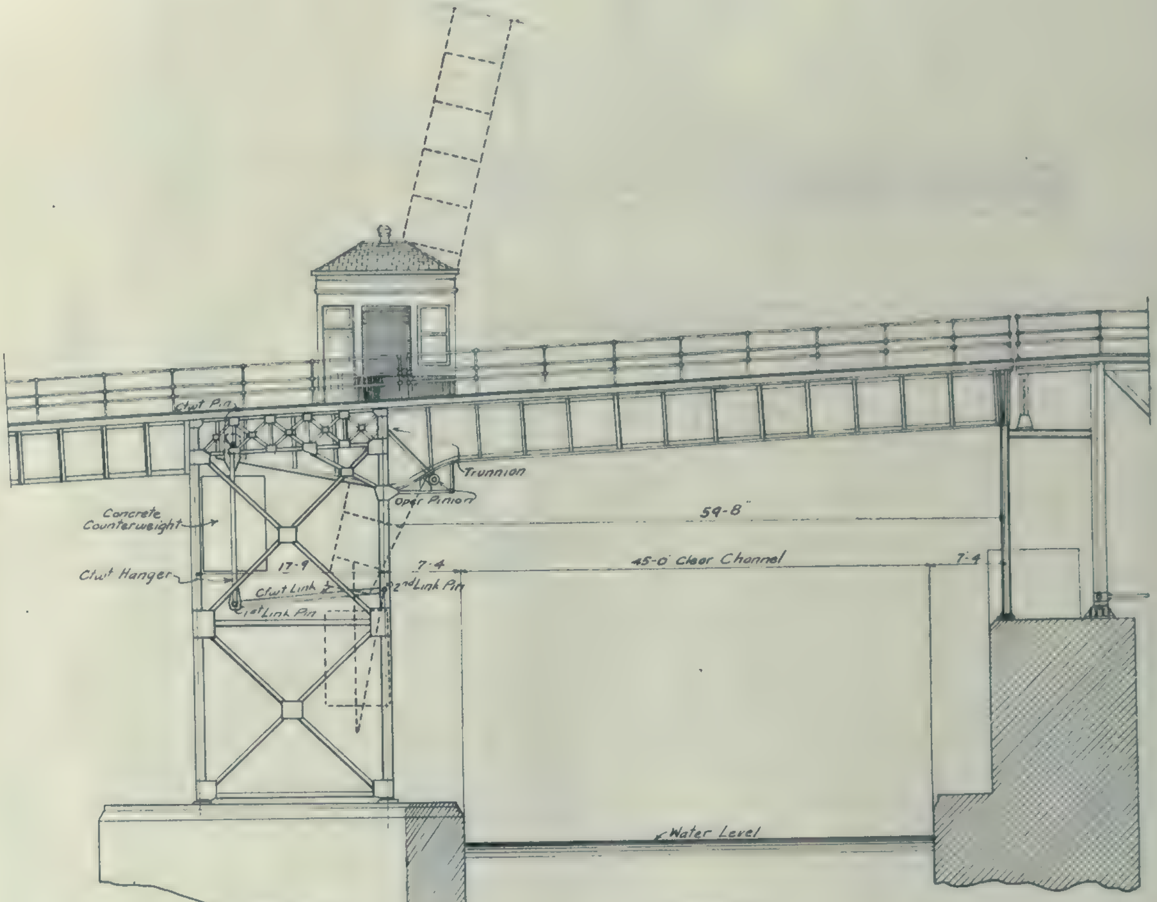


The highway bascule bridges of the City of Winnipeg.

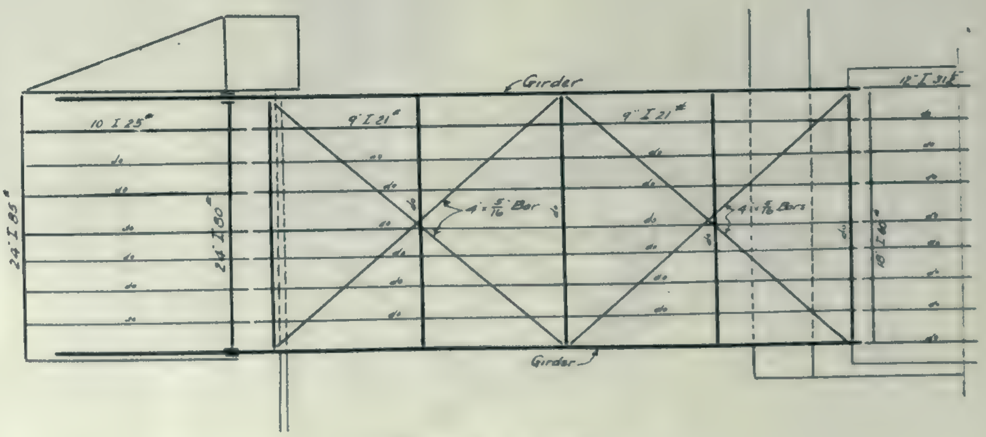

23-3' to ℄ Bridge
Top of Roadway at ℄ of Bridge Elev + 34'
Top of Masonry El 2539'
℄ of Main Trunnion
14-8'
4-0½'
℄ of Truss
1-7½
3-3
Provide Open Holes for Bearings
INSIDE ELEVATION OF INSIDE POST.
6-0
2¼ ⌀ Holes for 2" Bolts
℄ Outside Trunn Post
℄ Bascule Truss
℄ Inside Trunn Post
FRONT ELEV TRUNNION POST
Drill open holes 1⅛ turned bolts with casting in place. Shims of other bearings to be made for thickness required for proper alignment of trunnion
Typical Post Cap
Drill open holes for 1⅛ turned bolts with casting in place
PLAN OF TRUNN. POST CAP

Details of trunnion post, Osborne Street bridge, Winnipeg.

The highway bascule bridges of the City of Winnipeg



ELEVATION



FLOOR PLAN OF STEEL

Plan and elevation of bascule span at St. Andrews lock.

The highway bascule bridges of the City of Winnipeg

plank wearing surface on top. Each side of the bridge is provided with a three-line gas pipe rail.

The west approach, not including the main tower and the span over the locks, is somewhat similar to the east, with the exception that it is on a curve, the total length on the centre line being about 140 ft. The main tower is 17 ft. 9 in. centres of columns.

The span over the locks and adjoining the old bridge is a lift bridge of the Strauss Bascule type and spans the locks (59 ft. 8 in.) with one leaf. This leaf is composed of two plate girders and flooring similar to that on the other parts of the approaches. The counterweight for balancing the span is composed of a concrete block built around a steel frame and weighs approximately 83 tons. It is placed beneath the roadway of the bridge in the main tower. The operating machinery is also in this tower. The equipment includes a 15 h.p. motor for raising the span to enable boats to pass under while going through the locks. The operator's house is on top of the roadway and is connected with the north side of the main tower. It is provided with all the necessary switches and brakes for operating the machinery below.

This span was given its official test in November, 1913, and its efficiency was proved beyond a doubt, it being raised from its normal horizontal position to one almost perpendicular with the roadway and then lowered to the horizontal again in one minute and forty seconds.

Both the above bridges have been supplied and erected by the Manitoba Bridge & Iron Works Limited, Winnipeg, the Osborne Street Bridge under the supervision of Col. Ruttan, City Engineer of Winnipeg, and the St. Andrews Dam approaches under the supervision of Prof. Brydone-Jack, Winnipeg, Consulting Engineer to the Dominion Government.

The Art of Making Rapid and Reliable Preliminary Estimates of Cost

By Allen Hazen, Consulting Civil Engineer, New York City

ESTIMATING the cost of constructing proposed or existing structures rapidly and surely is an art. It is a valuable art and deserves cultivation. The success of many undertakings depends upon its use. Some men have the knack of estimating; others can never learn it. But good methods are essential and these can be studied and perfected and applied to special problems.

Estimates made for different purposes, are prepared in quite different ways according to circumstances. They may be conveniently classified under three headings:

(1) Preliminary estimates, being estimates made in advance of the preparation of detailed plans and specifications for the purpose of discussing a project for deciding as to its adoption, and for making the necessary financial arrangements for carrying it out.

(2) Detailed estimates, being estimates based upon detailed plans for the execution of the work, and usually made shortly before bids are asked for the particular work covered, or in advance of undertaking to carry it out by day labor.

(3) Final estimates, being the estimates to the contractor at contract prices for the actual work done. The term "final estimate" may also properly be applied to a statement of the cost of a completed work based upon actual expenditures made for carrying it out.

That which follows relates only to preliminary estimates.

Preliminary estimates are made much more frequently than others because only a fraction of the projects for which estimates are made are carried out. Less precision is expected in preliminary estimates than in detailed or final estimates, but on the other hand all reasonably attainable accuracy is desirable, for many important matters depend upon it. The decision as to which of two or more alternate projects is to be adopted frequently turns upon the preliminary estimates of the respective costs. The decision as to whether or not to undertake a certain enterprise usually turns upon the preliminary estimate of the cost of the work. A certain degree of reliability is, therefore, essential in preliminary estimates. On the other hand, preliminary estimates must be made for many enterprises that will never be carried out, and it is necessary that they should be made rapidly and without undue expense to the client.

Basis for Preliminary Estimates

There is only one real reliable basis for preliminary estimates. It is, the consideration of final estimates of work previously carried out, of a character and magnitude as nearly as may be similar to that of the proposed work. The more nearly the work represented by these final estimates approaches in all the conditions that for which estimates are being made, the more reliable, in general, are the preliminary estimates based upon it; and the more numerous and greater the points of divergence, the less reliable is the basis and the greater is the probable error in the resulting preliminary estimate.

Estimates in Valuation Proceedings

When a property such as a water works property is to be valued for the purpose of sale, it is common for engineers to make estimates of the cost of reproduction for the structures. These estimates may be in the nature of final estimates when the structures were recently completed and the actual costs are shown by records. They may be in the nature of detailed estimates when full plans and quantity schedules are available. More often they are in the nature of preliminary estimates because such detailed information and cost are not available. Preliminary estimates made in this way are commonly subject to comparison with like estimates made by engineers representing the other party to the transaction, and it is frequently necessary to harmonize such estimates by arbitration or otherwise. If they are presented as evidence in court the engineers who made them must support them through a searching cross-examination. The criticism of preliminary estimates made in this way is likely to be more searching than that of estimates made in the ordinary course of business, where the estimates are made for the purpose of construction and comparison only. For this reason the experience gained in valuing properties for the purpose of sale and in condemnation cases is more useful than any other experience that an engineer can have in training him in the first elements of sound procedure in making preliminary estimates.

Methods of Comparison

The problem presented in making preliminary estimates is this: given the final estimates of a certain number of works, more or less comparable to the one proposed, and a general outline of the works for which an estimate is to be made to find the probable fair reasonable cost of construction of the proposed works. The general procedure is to find the elements of cost in the work that is to be carried out, and the actual cost of those elements in the works for which final estimates are available, and to apply the latter to the former. In doing this all known differences that would affect, to an important extent, the probable cost of the work, must be taken into account and allowed for to the best of the estimator's ability.

Basis of Estimate

An estimate may be said to be low, fair, or liberal, according to the methods used in making it. A fair estimate may be defined as one such that with the work carried out in a business-like way under average conditions, there is somewhat more than an even chance that the work could be completed within the estimate. In the case of structures of types that have been built frequently, and of which the elements of cost have been well determined, experience indicates that it is possible in most cases to approximate, in preliminary estimates, the cost of new structures within 10 per cent. of the actual cost. With such structures a fair estimate would be somewhat between the most probable cost and 10 per cent. more than this, or, in a general way, 5 per cent, above the most probable cost. With an estimate made in this way, it should be possible to keep the actual cost of construction within the estimate three times out of four, and this is figuring as closely as an engineer can be expected to do.

In the case of structures of greater novelty, or structures involving undetermined underground conditions, greater fluctuations must be anticipated and the above-mentioned percentages should be increased.

Erroneous Methods of Reaching Estimates

In a valuation proceeding, it is frequently surprising that reputable engineers will present on different sides, estimates differing so much for the same item. These differences must frequently grow out of the use of erroneous methods of procedure by the respective engineers. It may be well, therefore, to consider some of the commonest methods that are erroneous, and to point out the reasons why they should not be used.

The Contract Price Method.—The columns of the technical journals contain a record of the prices at which many contracts are awarded. By going through these columns and selecting the low bids and applying them to the proposed work, an estimate may be prepared which will probably be much below a fair estimate for the work. Among the reasons that it would probably be low are the following:

First, many of the low bidders have under-estimated the difficulties of the work, and their bids are really too low. That is, they are not sufficient properly to carry out the work and make a fair profit. The contractor may not be able to complete the work under the contract and additional expense to the owner will have to be met.

Second, in applying the bid prices, or contract prices to new work, it is very easy to overlook entirely some items in the work. A price that relates to a part of the work may be taken as applying to the whole of it through ignorance or failure to make a fair and full comparison.

Third, the schedule of quantities prepared by the engineer for use in the specifications on which bids were obtained may be inaccurate and may not correspond with the final quantities when the work is completed.

Fourth, the items of extra work growing out of conditions that either were not anticipated, or that were intentionally excluded from the contract by the engineer as a matter of policy, are overlooked and ignored.

For these and similar reasons, estimates prepared from contract prices, or from low bids reported are almost invariably too low and frequently may be too low by a very large percentage. The figures may be arranged to make a very convincing showing in support of it, but it remains notwithstanding a low estimate.

Estimates Based on Averages.—In many municipal and corporate reports one may find records of the monies actually expended in carrying out certain developments. It is easy to find such records and to compile them and to deduce from them a figure which may be used as representing the probable cost of a proposed work of similar character. Some works represented by such figures may have been done in an efficient and economical manner, and the figures so obtained may be reliable and proper ones for use. Frequently, some or all of the work taken for use in this way was done under conditions that were not efficient, and the cost of doing it may include other items than those relating to the construction work. It is easy to select data in this way to back up a high estimate, and to make a showing that is convincing to those not familiar with the methods.

A Fair Basis of Estimate

A fair basis of estimate does not exclude either of the above methods, but will take into account data secured under either for what it is worth, and will make allowances for the conditions, or supposed conditions, under which the bids were received, or the work was done. A fair basis of estimate will also give much greater weight to final estimates of work as comparable as may be to the work that is proposed where the work was done under conditions known to be careful and economical. The engineer in making such estimates will naturally and rightly give greatest attention to work done under his own direction, and will give second place to work done by his friends and acquaintances with which he is reasonably familiar as to conditions met and methods used in the construction.

The Weighted Price Method

The number of different kinds of work for which unit prices may be obtained is very great. If an effort is made to keep track of the amount of work of each kind, and to estimate the amount of it in the proposed work, the schedule will be too complicated and the labor of applying the figures will be unduly increased. Moreover, if the schedule used for comparison is too complicated, some items are sure to be overlooked.

with the result that too low a final figure will be reached. In order to prevent both of these conditions it is frequently best, in preparing preliminary estimates, to take only a limited number of the main items of work that are involved in the kind of construction that is contemplated, and to weight the unit prices for them in such a way that they will include the whole cost of all the incidental items naturally associated with them.

In proceeding in this way one selects first the items that are to be used. These items should be so selected as to include directly the major part of the work. The final estimates that are to be used as a basis are then taken for analysis. The whole cost of the work represented by each is then distributed among the selected items. Considerable judgment is required in the distribution, and each part of the construction should be included with the item to which it is most nearly related. The most important point is that every dollar spent should be charged under some one of the selected headings.

The sum of the costs reached in this way, divided by the quantities in the final estimate, gives new unit prices which are weighted to include all the minor items. Applying these unit prices to the main items of the proposed work gives a basis for preliminary estimate.

As illustrations of these methods, take the case of pipe-laying. The trenching, the lead, the cast iron pipe, the teaming and incidental expenses may all be represented by separate items in the final estimate that serves as a basis. These can obviously be consolidated into a single item per lineal foot of pipe of a given size. In this process the price for pipe is weighted to include the other expenses that naturally go with it. The process may be carried further and the pipe still loaded to include the gates, the hydrants and all auxiliary structures.

In a similar way the cost of the reinforcing and of the forms for concrete construction first stated as separate items, may be consolidated, and all the different classes of concrete may be brought into one so that a unit price for masonry includes reinforcing and forms, and all the appurtenances that go with the masonry structures.

In estimating the cost of sand filters the writer has for years divided the whole cost of the construction into four parts, as follows:

(1) Excavation and earth work.
(2) Masonry.
(3) Filtering materials.
(4) Piping and auxiliaries.

The cost of each plant built worked out in this way on a uniform basis affords a basis for rapid and accurate comparisons, and allows the data to be applied in making preliminary estimates for new work where the prime conditions of construction are known with comparatively little chance of large error.

Weighted unit prices of this kind must be carefully obtained and can only be used with caution. The amount of weighting must always be kept clearly in mind by those who use them. When properly deduced and used, they afford an extremely useful and rapid method of approximating the cost of many structures.

The Ratio Method

There are many cases where the system of weighted unit prices cannot be used because the schedules in the final estimates that serve as a base are in such form that unit prices cannot be deduced from them. For example, there are many cases where the amount and character of work are known and the total cost of the work is known, but there is no way of sub-dividing it between the different items. To compare the costs of different pieces of work with each other, and to get a basis for estimating the probable cost of other similar work is then much more difficult.

A method of reaching an approximate and useful solution of this problem is one which may be called the ratio method. A schedule is made of a limited number of items of work which represent the greater part of the construction in the several cases. A simple schedule of unit prices is then formed corresponding to the units. One fixed price is assumed for each kind of work. The price assumed should be a reasonable one, but precision is not to be expected and a round figure may always be used. The amount of work under each item in each job is ascertained and the assumed prices are applied to them. The sum of the amounts for each job represents what that job would have cost at the assumed prices. A comparison between the actual cost and the cost at the assumed prices gives an idea of the relative economy of the work. It may be found, for example, that one piece of work cost 20 per cent. more than the amount obtained by applying the assumed prices; another piece of work cost 12 per cent. more and a third, 7 per cent. less. When the records of a number of known pieces of work are compared in this way, it furnishes a basis for making a preliminary estimate for work of the same class. In doing this the quantities for the proposed work are ascertained, the base prices are applied to them and a ratio by which the sum so reached is to be increased or diminished is ascertained by consideration of the ratios actually found to have been obtained in the jobs for which cost records are at hand.

In arriving at the ratio to be used the engineer will compare, perhaps in his mind and without written schedules, the ease or difficulty of the proposed work as compared with the ease or difficulty of the various works which served as a base; will take into account the known or assumed efficiency or lack of efficiency in the execution of the several pieces of work from which his basic data were derived, and will reach an estimate of the addition or subtraction to be made to or from the base price in each case.

This method is commonly combined with the preceding. That is to say, the base prices are usually loaded prices.

This method affords a convenient and efficient method of comparing the relative costs of different works where the loaded unit price method cannot be applied and in experienced hands it affords a rapid and reliable method of making preliminary estimates upon many classes of structures.

Extra Cost of Novel Designs

Work on novel designs commonly costs more than work following standard designs. This is true even when well tried methods are first introduced in new places. Such work may be too small to attract bidders from a distance. The unit cost will then overrun anticipated prices. An under estimate of cost is frequently made on work because the estimator fails to realize what a great effect familiarity with the methods of performing work has upon the cost. To realize this one has but to think of the difference between present methods and costs of building tunnels and subways and deep foundations, and the methods and costs of only 15 or 20 years ago. Not only is the risk which the contractor takes now less but methods which have been thoroughly tried out are at his disposal as well as experienced foremen and laborers to do the work more economically. For a structure of new or novel design much caution in using prices that may be standard on other kinds of work must be used.

Small Jobs Cost More in Proportion than Large Ones

Another common cause of under estimating costs is the use of figures on large pieces of work for estimating small work. The engineer often overlooks the large cost of overhead charges, the waste of labor and the cost of plant caused by organizing a force to perform a small piece of work. He too often forgets that for small work the work must be done by less efficient methods or the cost of plant prohibits the use of expensive machines. Perhaps the most common case of such under-estimating is where the job, although a large one in the aggregate, consists of many small pieces of work of widely varied character. Such a job is troublesome and costly for the contractor and the experienced man knows it and puts in a corresponding bid.

It must be remembered that bids follow the law of supply and demand; the general slackness in construction work calls out bidders and low prices. The condition of the money market, the cost of materials and the general opinion of the condition of contract work are of course matters of much importance. It seems scarcely necessary to say that the engineer should know where and how the contractor is to obtain his materials and have a fairly definite idea of the cost either in dollars and cents or as a comparative figure to other work.

The engineer in estimating should try to look at the work from the standpoint of the contractor, should try to remember that no work runs as smoothly along as the contractor wishes, that labor conditions and other matters often spoil the best laid plans. He should endeavor to keep in mind the various work he has watched or performed and the numerous times when unexpected conditions added largely to the cost.

Generally speaking, estimates on proposed work by men of limited experience are too low, yet it is not unusual for an engineer to be so impressed with the difficulty of a piece of work that he overestimates the actual cost and it is more common to find that he has overestimated the bids of the contractors.

It is of much value to have two methods of arriving at estimates. If an independent check method can be made even though a rough one, a failure of the two results to agree often leads to the discovery of serious errors in the application of one or the other method.

Conditions of Success in Estimating

One of the first requisites for successful estimating is a fair and unprejudiced, and moderately pessimistic mind. The estimator must be alert for new and cheaper processes and methods, and conservatively sceptical concerning their merits. Moreover, a successful estimator must have had experience in actual construction. As a general rule an engineer should not make an estimate for a structure that he would not know how to build.

Next, as a requisite to successful estimating, may be mentioned a broad basis of cost records of actual work, more or less similar to that for which estimates are to be made. A good and safe method of using the cost data and adjusting it for application to new conditions is equally important.

And, finally, the estimator must have the will to refuse to make estimates for work that he does not understand.—Engineering and Contracting.

Constructional features of the B.C. Division of the Canadian Northern Pacific Railway

THE total length of the main line of the above railway in British Columbia is five hundred miles. Approximately sixty miles remain to be graded. The principal contractors are the Northern Construction Company, who have the section from Port Mann to Hope and who are also associated with the line from Hope to Kamloops and from Kamloops to Yellowhead Pass. In all, between Port Mann and Yellowhead Pass, there are fifteen divisions. The length of the division is determined by the difficulty of the work. The divisions range from thirty to sixty miles in length. During the winter months the maximum survey force was 180 men. No great difficulty was encountered owing to weather conditions except in the Fraser and Thompson canyons, where work was carried on under extreme danger on account of the rock and clay bluffs.

The ruling west-bound grade is 4/10 of 1 per cent., compensated, and extends for fourteen miles. The ruling east-bound grade is seven-tenths. The heaviest cost for a single mile of grading, exclusive of tunnels, track work or structures, was $198,000, the yardage represented being rather more than 240,000 cu. yds. The length of rock fill in the Fraser River bay at the west end of the Sumas Mountain is 500 ft., representing 49,500 cu. yds. The width of the Thompson slide, where the Canadian Northern Pacific railway crosses, is approximately 500 ft. At this point over 100,000 cu. yds. were taken down. Monitors (manufactured by the Phoenix Iron Works, Portland, Ore.) with 2½ in. to 4 in. diameter nozzles were used. The water pressure was 120 lbs. per square inch. The water was supplied from 12 in. and 14 in. pipes from a creek distant about a half mile from the work.

Where the work was carried on over the Grand Trunk Pacific in the vicinity of Moose Lake, six trestles, located about 1,000 ft. apart, were erected for the purpose of taking care of the material.

In all there are 44 tunnels in British Columbia between Port Mann and Yellowhead Pass. The total length of these tunnels is 23,704 ft., the construction having been chiefly through solid rock. A large proportion of the tunnels required timber lining.

At the annual meeting of the Canadian Fairbanks-Morse Company, Montreal, last week, the president, Mr. H. J. Fuller, expressed the opinion that the business situation in Canada, which had resulted from the over-exploitation of lands and real estate, had re-acted to a healthy basis. Undoubtedly the country would have to go through a trying period of re-adjustment. but with the gradual easing of the money situation and the continuous flow of emigration there could be no question as to the ultimate future of the country. The Fairbanks-Morse Company's net profit for 1913 was $224,792.

A brick that, experts declare, was absorbed by natural growth round it two hundred years ago, has been found in a beech tree, computed to be five hundred years old, which has just been felled at Shardeloes, Amersham.

Specifications for Reinforced Concrete Highway Bridges and Culverts

THE following recommendations were submitted to the American Concrete Institute, at its recent annual convention in Chicago, by the Committee on Reinforced Concrete Highway Bridges and Culverts. These recommendations were submitted, not as final, but merely as preliminary suggestions, in the hope of bringing out the discussion of doubtful points and information regarding questions which the committee could not answer.

Dead Loads

The following are given as average weights per cubic foot of the materials mentioned, but if the weights of the materials to be actually used are definitely known to be different from those given, the correct weights should be used:

Materials	Lbs. per cu ft.
Earth filling	110
Plain concrete	150
Reinforced concrete	155
Steel	490
Cast iron	450
Vitrified brick	140
Common brick	125
Granite and limestone masonry	165
Sandstone	160
Macadam-Telford	150
Pine, fir, etc.	42
Oak and yellow pine	48
Creosoted timber	60

The weight imposed by earth filling should, in ordinary cases, be considered as including all filling included between vertical planes passing through the faces of the abutments.

If, however, the height of the fill exceeds about two-thirds the distance face to face of the abutments, the live load may be neglected and a very considerable proportion of the weight of the filling considered will be supported by friction between it and the approach filling. The amount of load thus transmitted is greatly affected by the cohesion of the soil, of which there is nearly always more or less.

This whole subject requires further investigation.

Live Loads

Class "A" Bridges.—Main thoroughfares leading from large towns.

In view of the extensive introduction of the heavy motor trucks and traction engines, and the probable general use of such vehicles in the future, it is recommended that bridges on main thoroughfares and other roads which are likely to be used for heavy hauling, be designed to carry 20-ton trucks, with axles about 10 ft. center to center, 14 tons on rear axle and 6 tons on fore axle; wheels about 5 ft. center to center. Outside of the large cities it is recommended that only one such vehicle be assumed to be on the bridge at any one time, the likelihood of more than one being on the bridge, in a position to produce maximum stresses at the same time, is so remote that this assumption is considered as occupying only the ordinary width of the road, about 8 ft. in width and about 35 ft. in length. Congested traffic of heavily loaded wagons or motor trucks will rarely impose a load of more than 100 lbs. per square foot, over a considerable area. The above mentioned 20-ton truck gives a load of about 140 lbs. per square foot on the area actually occupied, but it is considered extravagant to assume that a large bridge is covered with such heavy loads. A load of 100 lbs. per square foot is thought ample to assume for the loading of spans more than 60 ft. long, in designing the trusses or main girders. It is thought to be safe to reduce this assumed load in the case of longer spans, to the following values:

Length of span, ft.	Assumed load, lbs. per sq. ft.
80	90
100	80
125	75
200 and over	70

With all intermediate spans in proportion.

The greatest load that is liable to be imposed on a bridge sidewalk occurs when there is some excitement in the neighborhood, which attracts a large crowd, and for which the bridge affords an especially good point of view. In that case the crowd forms a compact mass, against the railing, not more than 4 ft. deep, making a load seldom exceeding 100 lbs. per square foot over a very considerable space. The remaining portion of the sidewalk may be covered by a moving crowd which can scarcely weigh more than 40 lbs. per square foot. It may be advisable, sometimes, to so design sidewalk slabs that if a street car or motor truck accidentally gets upon the sidewalk it will not go through. Such accidents are so rare that it is thought safe to allow materials to be stressed somewhat beyond the elastic limit in such cases.

Class "B" Bridges.—Although it is impossible to determine beforehand, especially in the newer parts of the country, whether any given road is to be used for heavy traffic, it seems extravagant, at least in the case of larger spans, to design bridges to carry much heavier loads than can be expected to come upon them. It is recommended that bridges of this class be designed to carry 15-ton trucks, with axles 10 ft. apart, 5 tons on the front and 10 tons on the rear axle. This will allow for a considerable overloading of existing motor trucks. It is further recommended that only one truck be assumed to be on the bridge at one time, in designing the floor system, that it be assumed to cover a width of 8 ft. and a length of 35 ft. and that the remainder of the bridge is covered with a load of about 90 lbs. per square foot for spans up to 60 ft.

The longer spans, the trusses and main girders should be designed for the following loads:

Length of span, ft.	Assumed load, lbs. per sq. ft.
80	80
100	70
125	65
150	60
200 and over	55

Sidewalks should be designed to carry the same loads as in the case of Class "A" bridges.

Special Bridges.—City bridges and bridges carrying traffic connected with mines, quarries, lumber regions, mills, manufactories, etc., require special consideration and should of course be designed to carry any load which can reasonably be expected to pass over them, bearing in mind the likelihood of heavy traction engines and motor trucks coming into extensive use in the not distant future.

Stringer Loading.—The maximum stress in a stringer, due to a wheel load, occurs evidently when the wheel is directly over it. It is not thought proper to assume any distribution of the load to adjacent stringers, unless the bottom reinforcement in the slab is made continuous. In that case the distribution is proportional to the relative stiffness of the slab and the stringers, said stiffness being proportional to the moments of inertia multiplied by the modulus of elasticity of materials, and inversely proportional to the cube of the span. In determining this distribution, due account must be taken of the fact that deflection of the slab decreases toward the end of the stringers, and also of the fact that whatever load is carried to the adjacent stringers deflects them also. It is therefore recommended that wherever practicable the bottom reinforcement of slabs be more continuous over the stringers.

Slab Loading.—The distribution in a direction parallel to the supports of a concentrated load resting on a slab, supported at two opposite edges only, evidently depends upon the same principles as those mentioned under "Stringer Loading." The main difference being that what corresponds to the stringer in the former case is of indefinite width in the present case. Adequate theoretical investigations of this question appear to be lacking. For the present it seems fair to assume that the distribution each side of a concentrated load is equal to about one-third the length of the span, and that the cross reinforcement should be designed accordingly, which would require it to have an area of at least one-half of the principal reinforcement. The distribution of a concentrated load through earth filling on the top of a slab does not appear to be very well understood.

Bridges Carrying Electric Cars.—Electric traction is still in its infancy and nobody is able to forecast its future development. It seems probable, however, that it will not be profitable to run cars weighing more than 50 tons each, at a speed that would be permitted on any public road. If very high speeds are desired, the traction company will doubtless be required to operate over its own right-of-way. It is recommended that bridges carrying either urban or interurban electric cars be designed to carry 50-ton cars on two trucks, spaced 30 ft. centre to centre, each truck having two axles spaced 7 ft. centre to centre. The committee sees no reason for changing the customary practice of assuming that an axle load is distributed over three ties.

Loading on Arches.—The deflection of an arch being much less than that of a beam of the same length, the method recommended for determining the lateral distribution of a concentrated load over arch sheeting appears to be different from the distribution over flat slabs. It seems doubtful if the distribution in each direction can be greater than twice the thickness of the arch sheeting. This question should be investigated.

Stresses in Arches.—As all arches that are not provided with hinges act as elastic arches until cracks are formed, due to excessive tension at some point or points in the concrete, it is manifestly proper to calculate the stresses in them according to the elastic theory.

As concrete is a very poor conductor of heat, it is not thought necessary in calculating reinforced concrete arches to assume so much variation in temperature as is usual in designing steel structures, although the outside layers of concrete are of nearly the same temperature as the surrounding air, and those layers are stressed more heavily than any of the others. It is thought that an extreme variation of about 80 deg. F. in the northern states is sufficient to allow for, in any case, and that can be reduced if the arch ring is thicker or if there is much earth filling in the spandrels.

Bearing Power of Piles

The usual formula for the safe bearing power of wooden piles is:

$$B = \frac{2WH}{S + 1}$$

in which

W = weight of hammer in pounds.
H = weight of fall of hammer in feet.
S = penetration in inches per blow, average of last few blows.

If reinforced concrete piles are molded before being driven, the head of the pile is usually cushioned more or less and the pile is generally much heavier in proportion to the weight of the hammer than is the case with wooden piles. It is recommended that the hammer should be at least as heavy as the pile.

If concrete piles are molded in place, measures should be taken to prevent damage to them by the driving of neighboring piles or otherwise.

Bearing Power of Soils

This subject is under investigation by a committee from the American Society of Civil Engineers. It may be some years before their final report is submitted and even that will be subject to revision from time to time, as human knowledge is extended. In the meantime the committee would submit the following preliminary table:

Material	Safe bearing power tons per sq. ft.
Quicksands and wet soils	0.1 to 1.0
Dry earth, according to depth below surface	1 to 3
Moderately dry clay, confined	2 to 4
Dry stiff clay	4 to 6
Sand confined	2 to 6
Sand compact and cemented	4 to 8
Gravel cemented	8 to 12
Rock	25 to 200

Foundations should be carried down below frost unless they are on rock and thoroughly drained. Soil that contains the roots of plants is generally compressible. Undisturbed soil is much less compressible than filing or similar soil, even though it has been in place many years. The bearing power of sand, gravel and dry clay increases rapidly with the depth below the surface of the ground. None but the smallest structures should be founded on earth filling.

The pressure of earth against abutments, wingwalls and retaining walls varies so widely with the character and condition of the earth in question, that nothing more than a few general suggestions can be given. It is hoped that the committee from the Society of Civil Engineers, which is studying the bearing power of soils, will take up this subject also. In ordinary cases where the filling is well drained its pressure will sel-

1914 28(

dom be more than that of a liquid weighing 25 lbs. per cubic foot, and is frequently much less. The pressure due to land slides is often several times this amount. If the filling is clayey and is allowed to become waterlogged, its lateral pressure is greatly increased. The effect of the freezing of the filling must also be considered.

Required Waterway

The usual formula for a waterway for culverts is:

$$a = C A^{3/4}$$

in which

a = required area of culvert in square feet.

A = drainage area in acres.

C = a constant, depending on the length and character of the drainage area and may vary from about 0.3 to 2.0 in regions where the mean annual rainfall is about 50 ins.

Waterproofing Masonry

A comprehensive report of forty-eight pages on waterproofing masonry, the results of five years of investigation, was submitted at the recent annual meeting of the American Railway Engineering Association by the committee on masonry. The committee discusses coatings, membranes, integrals and watertight concrete construction, and include five pages of diagrams showing methods of waterproofing bridge floors of various types, arches, subways, expansion joints, etc. The following conclusions are recommended for adoption in the "Manual":

1. Watertight concrete may be obtained by proper design, reinforcing the concrete against cracks due to expansion and contraction, using the proper proportions of cement and graded aggregates to secure the filling of voids and employing proper workmanship and close supervision.

2. Membrane waterproofing, of either asphalt or pure coal-tar pitch in connection with felts and burlaps, with proper number of layers, good materials and workmanship and good working conditions, is recommended as good practice for waterproofing masonry, concrete and bridge floors.

3. Permanent and direct drainage of bridge floors is essential to secure good results in waterproofing.

4. Integral methods of waterproofing concrete have given some good results. Special care is required to proportion the concrete properly, mix thoroughly and deposit properly so as to have the void-filling compounds do the required duty; if this is neglected, the value of the compounds is lost and their waterproofing effect detroyed. Careful tests should be made to ascertain the proper proportions and effectiveness of such compounds.

Integral compounds should be used with caution, their chemical action on the concrete being ascertained as well as their effect on its strength. As a general rule, integral compounds are not recommended, since the same results as to watertightness can be obtained by adding a small percentage of cement and properly grading the aggregate.

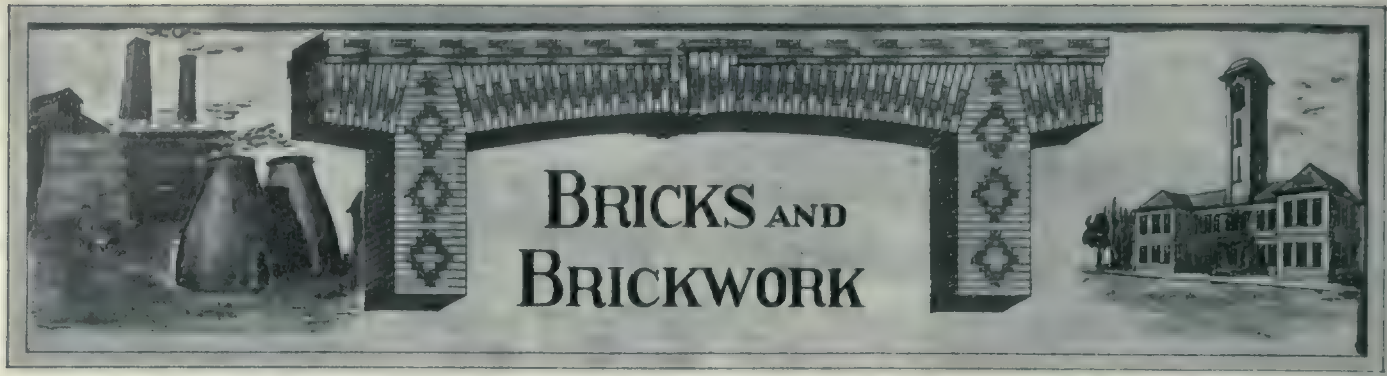
5. Surface coatings, such as cement mortar, asphalt or bitulithic mastic, if properly applied to masonry reinforced against cracks produced by settlement, expansion and contraction, may be successfully used for waterproofing arches, abutments, retaining walls, reservoirs and similar structures; for important work under high pressure of water these cannot be recommended for all conditions.

6. Surface brush coatings, such as oil paints and varnishes, are not considered reliable or lasting for waterproofing of masonry.

J. W. B. Blackman on Town Planning

TOWN planning was the subject of an interesting paper by J. W. B. Blackman, City Engineer of New Westminster, presented before the Vancouver Branch of the Canadian Society of Civil Engineers on March 17. Mr. Blackman showed how the science of town planning had taken hold of Canada since the passing of the Town Planning Act by Great Britain in 1909. On April 20, 1912, the Dominion Government granted to New Brunswick an Act Relating to Town Planning, while during the last session of the provincial government, at Victoria, B.C., a clause was embodied in the new Municipal Act giving cities the power, with the consent of two-thirds of the ratepayers, to pass bylaws for town planning. Quite recently Vancouver has been considering a scheme for a new civic centre. Mr. Blackman touched upon the more important points in town planning, urging particularly common-sense limitations as to the height and character of buildings. In Canada and the United States, he contended, our skyscrapers were the greatest enemy to the public health. Mr. Blackman cited the death rates of a number of the larger cities of the world and compared them with those of a number of the garden cities, and the comparison was most illuminating. The death rate at New Orleans, for instance, is 22.6 per thousand, while at Port Sunlight, in England, it is only 9.0 per thousand, and at Letchworth, England, still lower—only 4.8. The death rate at San Francisco is 20.9, at New York 19, Paris 18.2, Berlin 18.3 and at London 16.9. European countries generally are taking steps to prevent the physical deterioration of the race through lack of air, sunlight and sanitation. Australia's example in laying out the new Capital was to be commended and the example was one for Canada to contemplate. Mr. Blackman made a strong plea for diagonal streets and deplored the square block plan which had been followed in certain cities. One of the dangers in replanning a town or city lay in destroying the individuality that it possessed. The individuality of a place should be preserved and cultivated in the same way as personal individuality. This virtue of individuality, particularly noticeable in the older cities, was illustrated by lantern slides showing a number of European cities. The whole paper was copiously illustrated.

The Cooke Construction Company, the contractors engaged in the work of widening the Montreal aqueduct, a contract involving the expenditure of some two and a half million dollars, were ordered to cease operations last week by the city engineer, Mr. Janin, acting on the instructions of the controllers. The reason given is that the company in its excavation work in the rock sections had been endangering the foundations of the embankment of the aqueduct. The Cooke Construction Company had complete equipment and a large staff of men on the ground and it is regarded as certain that a series of law suits will follow the cancellation of the contract. Mr. Henry R. Lordly, the engineer-in-charge of the Lachine Canal made an independent examination of the work for the city.



Bonds in Brick Work

SEVERAL of the bonds that are now employed in exterior brick work are described in an interesting article by H. D. Eberlien. He says the most common bond, in fact, almost the only one employed during a great part of the Nineteenth Century, is the running bond, in which all the courses are composed of "stretchers," that is to say, brick laid lengthwise, the only "headers" or endwise brick visible being at the window jambs, at the starting of piers and pilasters and in straight header courses at more or less frequent intervals where their use is made obligatory by the local building laws to tie the face-wall to the backing. Each course breaks joints vertically with the courses immediately above and below. Running bond is perhaps the simplest and certainly the least interesting and artistic way of laying brick and has little to commend it except considerations of economy.

The Flemish bond, in which every course consists of alternate headers and stretchers is, after the running bond, the one we most commonly meet with, having been generally used in our brick buildings of Colonial date, in which the black header and red stretcher effect is so often noticeable. Flemish bond is constructionally honest, artistics and satisfying, and its almost universal employment in modern building of Colonial style cannot be too strongly commended.

The double-stretcher Flemish bond, as its name denotes, consists of two stretchers together, followed by a single header in all courses, the headers being laid above the joints between the two stretchers in the course next below. It is coming more and more into vogue in America and has been used in some of our largest buildings with signal success.

For the vertical joints between the contiguous stretchers mortar colored to exactly match the brick is often used, thus making a blind joint and giving the effect of one double-length stretcher. The use of double-stretcher Flemish bond sets a big, broad scale and can be employed to advantage in large wall surfaces, particularly where it is desired to take off somewhat from the appearance of height, as the strongly marked horizontal lines have that effect. This feature can be further emphasized by slightly increasing the thickness of the horizontal mortar joints.

English bond and Dutch cross bond, like both the single-stretcher and double-stretcher Flemish bond, are replete with artistic feeling and deserve to be far more widely known and used than they now are in America. Not only are they essentially artistic but they are strong and honest in structure. Both English bond and Dutch cross bond have alternate courses, the one wholly of stretchers and the next wholly of headers; but in the English bond the stretchers of the first and fifth courses break joints with the stretchers and of the third and seventh courses respectively and thus throughout, giving a diagonally diapered appearance if the mortar joints and the hue of the brick be judiciously contrasted.

The bonds mentioned are the most usual kinds, but one also meets with special adaptations of recognized types; it is, however, quite sufficient for general purposes to remember the five enumerated. In fact, many people, who are supposed to have some knowledge of such matters, have difficulty in keeping the differences clearly in mind and generally fall down in trying to describe them.

Brick Roads Without Permanent Curbs or Edging

IN a paper presented at the twenty-ninth annual meeting of the Illinois Society of Engineers and Surveyors by Mr. W. T. Blackburn, Paris, Ill., the construction of two brick roads built without permanent curbs or edging was described as follows: I have in mind a brick country road 9 feet in width that has been in constant service since 1899 (14 years). The roadway was constructed according to what is known as the two-course method and was composed of brick on edge for wearing surface, resting on a cushion of sand, supported by a number 2 paving block foundation. Two-inch boards were placed along both edges level with the finished brick surface to act as an edging. The earth was graded up level with the surface of the pavement. The boards are almost all gone, either having decayed or having been lifted by frost and removed. This roadway is in excellent condition and has demonstrated that a country road can be successfully built in this manner.

An experimental section of brick road about 300 feet long has been recently constructed to connect the above described road with another brick pavement. This section is provided with a 4-in. concrete foundation made smooth by the use of a template drawn over boards set to grade along the sides of the foundation. On the foundation was placed a well-compacted sand cushion 1½ inches in depth, and on this was placed a brick surface made smooth by rolling. Care was exercised that the joints were left open and they were afterwards filled with a cement filler made of 1 part cement to 1 part fine sharp sand. The precautions were taken to place the fractured ends of the bats away from the edge of the pavement, and to use nothing smaller than half brick at the edges, leaving the edge of the pavement finished with the perfect ends of blocks. The boards were then removed and the earth tamped along the edges of the pavement.

This experiment bids fair to demonstrate the practicability of building brick roads without the added expense of an edging. This pavement was built 9 ft. in width and should necessity require a greater width a 3 ft. crushed stone shoulder can be placed on each side.

Design and Construction of New Veterinary College, Toronto

TORONTO enjoys the distinction of possessing a new Veterinary College which has two features of outstanding interest to the building trade. The need of suitable accommodation for the advancement of Veterinary Science has been realized for many years by the Ontario Government, and the new structure, which is located on the west side of University Avenue, has been designed to fulfil the requirements of the veterinary branch in every respect. The building is claimed to be the largest of its kind on the American continent, having a frontage on University Avenue of 134 ft., on Simcoe Street of 49 ft., and on Anderson Street of 46 ft., its height from ground floor to cupola roof being 82 ft. The structure covers an area of 10,000 ft., and besides being the largest of its kind from the structural standpoint, it also possesses the largest anatomical laboratory on the continent—42 ft. by 104 ft.

The building is five storeys in height including the basement. The foundations are of concrete and the building of skeleton steel construction, being fireproof throughout. The main spans are carried on girders, and the design in this and other respects is similar to that of most buildings of the kind. The basement and first storey are of grey freestone, and the substructure is of Don Valley stock brick, with cut stone cornices and dressings.

The main entrance to the basement is from Simcoe Street, leading into an extensive stable to be used as an infirmary for horses, with an operating room adjoining. This latter will embody all the most modern features and equipment to be found in buildings of the kind. The caretaker's quarters are also located in the basement and these have an entrance from Anderson Street. The main entrance to the first floor is in the centre of the facade on University Avenue, through a stone porch with rusticated columns. The business offices and the Principal's rooms are located to the left of the main entrance, the remaining space being taken up with offices, lavatories, classrooms and storage rooms. The second floor contains a large laboratory, a classroom, faculty room and an assembly hall capable of accommodating five hundred students. The third floor is divided into a laboratory, a classroom, a library and a museum. The anatomical laboratory is located on the fourth or upper floor, and there are in addition an incinerator room, toilet and students' recreation and resting rooms. An elevator of the

New Veterinary College, Toronto.—An attractive building which exemplifies the possibilities of brick harmonized with stone in the exterior.

Otis-Fensom type extends from the basement to the anatomical laboratory.

In every respect the building is thoroughly up-to-date, ample provision being made for toilet and other conveniences. Each of the four laboratories is designed to accommodate a hundred and twenty students. A low-pressure steam heating plant is installed throughout, the boiler house, containing two tubular steam boilers supplied by the Berg Machinery Company, being located in the basement. Each of the classrooms situate in the basement, first and second floors, will accommodate a hundred and ninety students. It is expected that the college will be completed for the reception of students before the end of the present year.

The building which is electrically lighted through out, was designed, and plans prepared by Mr. F. R. Heakes, Provincial Architect, after a visit had been made in conjunction with Dr. E. A. A. Grange, Principal, Ontario Veterinary College, to a number of similar institutions throughout the American continent. The building involves an outlay of about $250,000. All the red stock brick used in the building—including perforated tile brick with which all the exterior walls and partitions are lined—to the number of about 1,500,000, were supplied by the Don Valley Brick Works.

The contract for the excavation for foundations was entrusted to Messrs. Thomson Brothers. Mr. Edward Gearing carried out the contract for the stone and brick work and fireproofing. The other contractors were:—Carpenter work, Messrs. T. V. Gearing and Company; steel work, Dominion Bridge Company; brick, Don Valley Brick Works; concrete, Messrs. A. Gardner and Company; heating, plumbing and ventilating, Messrs. Purdy & Mansell, Limited; plastering, Mr. A. D. Grant; electric lighting, Messrs. Bennett & Wright; exterior galvanized iron, Messrs. Douglas Brothers; painting and glazing, Mr. James O'Hearn; metal, frames and sash work, Messrs. A. B. Ormsby Company, Limited. The stable fittings were supplied by the Tisdale Iron Stable Fittings Company, Toronto.

Profit or Loss with the Steam Shovel[*]

An Analysis of the Various Elements which Produce Efficiency in Excavation Work and a Study of their Proper Co-ordination

THE biggest thing in construction machinery is the steam shovel. Its capacity for results is so large that even most men engaged in operating steam-shovel plants do not comprehend its profit-yielding possibilities. Ranging from the little number 0 revolving shovel, for cellar excavating, to the mammoth 250-ton stripping shovels of the Kansas coalfield, its range of usefulness almost passes belief.

The monster 110-ton shovels of the Panama Canal and the 95-ton shovels for heavy railroad construction are marvels of power, mobility and effectiveness, while the 60-ton and 70-ton standard shovels for general construction are, beyond question, the most useful machines with which modern general construction is equipped. The vital and ever-new problem of getting maximum results at minimum cost is employing the scheming minds of every owner, superintendent and foreman engaged in steam-shovel work.

Maintaining Maximum Output

As a general statement it may be said that it is not what a shovel will dig but what can be taken away from it that limits its output. It is common knowledge that a 70-ton shovel with 2½-yd. dipper will dig, if operated continuously, at the rate of 3,000 cu. yds. in ten hours. How often this rate is attained for even one day, to say nothing of twenty-six consecutive working days, is such an idle question, apparently, as to bring the smile of indulgence to the face of the ordinary steam-shovel man.

If this average be possible—and it is possible in the same sense that it is possible for the expert shot to make 100 per cent. in target practice—how vital and valuable, then, is the study and application of the means of its accomplishment! Some of us are prone to idealize, but to the average man perfection or near perfection is so remote as to lose its desirability.

If a shovel capable normally of delivering 3,000 yd. daily at 33 1-3 cents contract price per yard, or $1,000 daily return only returns $333 daily, the owner may well "sit up and take notice" when he is assured of the certainty of correcting it. The most general use for steam shovels is on heavy railroad construction, where the quantities of material to be moved are so large as to justify heavy expenditures for the attainment of low-unit costs, and of such it is the purpose of this article to speak.

Contract prices for excavation are usually based on the classification of the material to be excavated, so that in a general way it may be assumed that the same degree of operating efficiency that will return $1,000 daily in earth excavation will return about the same, plus additional expense for drilling, explosives, etc., in loose rock and solid rock. Hence the degree of operating efficiency shows practically the same proportional results in all classes of materials.

Three Vital Elements

There are three vital elements in steam-shovel operation: (1) The skill of the operating crew; (2) the upkeep and maintenance of the machinery, and (3) the provision for transporting the output. Under these three heads are numerous subheads, like so many links in a chain, the weakness or inefficiency or insufficiency of any one of which reduces the efficiency of the whole to its level.

The average labor, fuel, and oil expense of operating a standard shovel, not counting haulage, etc., or upkeep, may be assumed to be $40 daily, working under ordinary conditions and supervision. If the shovel digs 1,000 yd., the cost is 4 cents per yard. If it digs 3,000 yd., the cost is 1 1-3 cents per yard. But suppose that by doubling every item of expense either by increased wages for better men or larger crews, etc., the maximum of 3,000 yd. could be maintained. The cost per yard, then, would be only 2 2-3 cents, or still a saving of 33 1-3 per cent. over the cost of the 1,000-yd. output. How many shovel owners realize and put this into practice?

---

[*] By P. S. Fitzgerald in the Engineering Record.

Supposing, again, that the upkeep, repairs, new parts, etc., including half of the master mechanic's and blacksmith's expense, amounted in round numbers to $20 daily and that it was necessary to treble this to maintain the 3,000-yd. schedule; the unit cost would still be no larger.

This brings us to the transportation problem—the "pons asinorum" of the average operator. Assume only usual or typical conditions—narrow-gage equipment, 4-yd. side-dump cars, and 10-ton dinkeys. How many operators use sufficient trains to keep one constantly ready at the shovel? How many lay their tracks to gradients that will permit safe and continuous operation? How many provide run-around tracks in the cut so as to have one train ready at the shovel on the second the loaded train departs? How many keep surplus—sometimes idle (though usually unnecessarily so)—labor ready to throw track, extend track, back the shovel, and do the many things that cause commonplace delays at the shovel?

Take a typical case. Assume a long haul—with three trains, dinkeys and crews, fuel, water supply, track gang, trestle gang, dump gang, etc. The variable labor-expense items due to more or fewer trains are train crews, fuel, water, track gang and dump gang. It is seldom necessary to add more than one train to "take up the slack" in the ordinary haulage system. Hence, with a daily cost of $40, the unit cost of 1,000 yd. will be 4 cents, while with an increase to $60 for all items the 3,000-yd. output will cost 2 cents per yard —or a saving of 50 per cent.

Thus by increasing the efficiency expense all around $100 daily—or from $100 to $200—the actual unit cost is decreased from 10 to 6 2-3 cents, or an additional profit of 3 1-3 cents per yard, which for 200 work days on the 3,000-yd. schedule will amount to $20,000—sufficient to purchase outright an ordinary standard steam-shovel plant and have enough left to carry one month's pay-roll.

This, however, is the lesser of the two distinct profits to be gained by efficiency. If the contract price is 33 1-3 cents and the entire cost price, including interest, insurance, depreciation, temporary trestles, small-tool repairs, damage suits, overhead expense and the cost of miscellaneous items incident to steam-shovel work, is, in the 1,000-yd. case, 23 1-3 cents and in the 3,000-yd. case 20 cents, the profit on 26,000 yd. per month is $2,600 and on the 78,000 yd. per month $10,400, or four times as much. Not alone is the money a profit, but the reputation for prompt, efficient, successful work thus gained is a business asset that can hardly be reckoned in dollars. While the figures given are only illustrative, they surely serve to put in the spotlight that modern word for magic—efficiency.

Increasing Returns

The unthinking or overworked man is too prone to believe that in reducing expense lie profits. Never was theory so fallacious where results are measured in such large figures as in steam-shovel work. Additional expense for efficiency seldom outruns the gain, and never where brains, prudence and clear thinking are exercised. Of course, it is not intended to assert that by adding one train to three the carrying capacity will be trebled—but the idea is to provide ample transportation facilities so as not to delay the shovel at the maximum output.

It is the co-ordination of all the elements of the work that produces efficiency, and the principle here advocated is that it is the acme of intelligent economy to spare no expense, however, seemingly extravagant, to bring about perfect co-ordination. For instance, many owners protest at more than four pit men, when as a matter of fact six would mean often 10 per cent. gain in output; 100 yd. gain at 33 1-3 cents would seem a pretty handsome profit for an extra outlay of $4. For a shovel runner $200 per month seems high, but extra skill often adds 25 per cent. to the shovel's output, or 6,000 yd. monthly at 33 1-3 cents.

Many shovel owners scoff at such ideas and say there is nothing in them, but they seldom occupy high seats among the successful. Merely to spend money or pay excessive wages to keep idle or useless men is not the basis of this efficiency system, but not to withhold these things, when they are necessary and desirable, is the keynote. Co-ordination, ample facilities, brains, and everlastingly hitting the ball at maximum speed are prime requisites, and combined they spell efficiency and profits.

LETTERS

Editor Contract Record:

Will you kindly inform me through the medium of your valuable journal what amount constitutes an average annual expenditure on engineering works for a municipality with a population of about 20,000, and what is the ratio of staff expenses. If any of your readers can give me a few facts out of their experience it will be helpful to me and of interest to my council.

Yours truly,
City Engineer.

Recognition of Engineers

Halifax, N.S., March 24, 1914.

Editor Contract Record:

The subject of engineering organization discussed editorially in your issue of March 4 has been brought up at the meetings of the Nova Scotia Society of Engineers, and we realize the importance of it, but the difficulty of starting such a movement seems to be the stumbling block. I, myself, have no hesitation in opposing the idea of close corporations which you can put forward as a means towards this end; at the same time, I believe that something should be done to recognize engineers, who, by experience or technical training, should be in possession of a certain standing which is now accorded to other professions.

Yours faithfully,
A. R. MacCleave*

The Organization of Engineering Interests

Editor Contract Record:

After a careful perusal of the editorial article on the above topic published in the Contract R
am inclined to express hearty agreement with the principle, viz., the desirability of better organization and the co-ordination of the various branches of the engineering profession. At the same time I cannot overlook the fact that the field has become so vast that it is impossible for any one

---

*Assistant City Engineer, Halifax, N.S., Secretary Nova Scotia Society of Engineers.

man to keep in touch with the innumerable subjects offered, to say nothing of having any understanding of them. Meetings that would include the engineers of all branches would by their mere ponderosity crush or defeat their purpose. This is exemplified in a minor degree in the American Association for the Advancement of Science, wherein so much is not comprehended. The suggestion looking to a wholesale exchange of publications is unpracticable—and in any case too costly, as those who have attempted it in the surveying and civil engineering professions have found out. The details do not call for elaboration. As for keeping au courant of general engineering events, there is available to the profession the Engineering Index published by the Engineering Magazine Company. This covers eight branches of engineering and serves a most useful purpose. It is too true that live engineering societies exist only in the large cities; in the smaller cities it is a case of mere existence, or vegetation, and the only life is infused by one or two enthusiasts who, rain and sunshine, stick to their self-imposed, thankless task of securing for each meeting interesting material from competent men.

A panacea for lack of interest in society work has yet to be discovered. Local enterprise and local conditions govern. If the members are dead the society is dead; if the members are alive there is no reason why the society, also, should not be alive.

Yours very truly,
E. W. Hubbell.*

The Value of Architectural Competitions

Toronto, March 25, 1914.

Editor Contract Record:

I quite agree with the spirit of the editorial article relating to architectural competitions published in your issue of March 18. Undoubtedly, competitions, as they are now conducted in Canada, are very unsatisfactory. One must not overlook the fact, however, that the greater portion of public and semi-public work has to be competed for and that under existing conditions Canadian architects are forced to go into competitions. I am fully convinced that if the money expended on competitions were employed in engaging a reputable architect in whom the owners had confidence the results would be much better. The architect should make exhaustive studies and devote some time to visiting other buildings of a similar character. He should have repeated consultations with the prospective owner and thoroughly familiarize himself with his requirements.

It is well known that certain architects can do certain kinds of work to advantage. For instance, it is most likely that an architect whose practice is confined largely to domestic work would be in a position to handle an important public building. His training and experience are entirely contrary to the spirit of the larger problem.

If a man is seriously ill, he certainly does not advertise for competition among doctors to find out who is going to give him treatment and to see what treatment he would prefer to have; he makes enquiries and goes to the best man he can find.

The idea is sometimes advanced that by means of competitions some heaven-born talent is brought to light. This contention is not borne out by experience.

It will usually be found that work of an important character does not come to any architect, either by competition or otherwise, until he is competent to undertake that work. The younger architects will have to fight their way up, just as their elders have done.

If competitions are to be held, I think the proper method of conducting them is for the committee in charge of the competition to select four or five architects of standing in the community, any one of whom they would be satisfied to have erect their building. These architects should be amply paid for their services.

While on this subject, it has always seemed to me that those responsible for the programme of requirements make two mistakes. In the first place they usually ask for too many drawings. What is the sense of asking an architect, in a competitive set of drawings, to submit a basement plan or a roof plan. They surely have no bearing on the parti, but only make additional work for the architect. Secondly, they so word the programme and give such definite instructions as to preclude any variation of solution, thereby defeating one of the primary objects of the competition.

Very truly yours,
John M. Lyle.

Should the Engineering Profession be a Closed Corporation?

Calgary, Alta., March 19, 1914

Editor Contract Record:

I have read with much interest the editorial, entitled, "The Organization of Engineering," in your issue of March 4. I have given this subject considerable thought recently and have almost come to the conclusion that the engineering profession should seek legislation to form a closed corporation. Being young in the profession I hesitate to express such a view, but I believe that this is the opinion of a very large number of engineers. Looking at it first from the point of view of the general public: should there not be some means by which any person can distinguish between the qualified and the unqualified engineer? There is legislation to prevent the untrained and incompetent from practising medicine, surgery, dentistry and law, and we all know that a doctor, dentist or lawyer who obtains a license is at least competent and trained for ordinary professional responsibility. Even the land surveyor—quite properly, I think—has to obtain a license. If it is necessary to protect against the unqualified in other professions—and we all know the advantages of that protection—is it not equally desirable to protect against the unqualified engineer? Many of the blunders and failures attributed to the engineering profession are really the work of some pseudo-engineer, who has, as you say, by push and effrontery, bustle and bluff, secured the work. Under present conditions the ordinary person cannot distinguish between the qualified and the unqualified engineer, and as a result, many of the fees are diverted from the legitimate pockets. Of course it is nobler to have gained the distinction of being a great engineer in an open race, but the few who gain that distinction might well forfeit a little of the glory for the sake of the very many who do not gain distinction.

I quite agree with the President of the Illinois Society of Engineers and Surveyors who recently stated: "This is the day of organization; individual effort fails. In business, consolidation alone survives. If engineers are to progress and to retain their rightful sphere, they must do so through organization."

We must become strongly organized to guard and advance our interests in legislation and in public relations.

There should only be one organization for the whole Dominion—not a separate organization for each province or each branch of engineering. The civil, mining, mechanical and electrical engineers are usually educated in the same institution and after all they use the same fundamental ideas and general principles in their work. There is, therefore, no reason why they should not work shoulder to shoulder in one society for the general welfare of the profession. Instead of creating new societies the existing ones should be broadened to meet the requirements, and, if possible, amalgamations should be effected. The suggestion that the different societies should exchange "Proceedings" is a very good one, but I would go further and suggest that joint meetings would be much more effective, provided the papers and addresses were not too technical, so that everyone in the audience could understand and take part in the discussion. The reading of purely technical papers is almost a waste of time in a general meeting, as it is impossible for the audience to grasp the full meaning or arguments by listening to a paper read hurriedly. The publication of the highly technical papers is the proper means of disseminating them. Addresses on general subjects are much more interesting for general meetings and do a great deal towards broadening the engineer, which is what he requires.

---

*Secretary of the Association of Dominion Land Surveyors.

I think, therefore, that the engineering societies should all work together and the ideal condition would be reached if there were only one society divided into departments for each branch of engineering. One strong and truly representative organization can accomplish a great deal more than several mutual admiration societies.

Incidentally I may add that much can be done to advance the interests of the profession by the proper kind of publicity work. Everyone has heard the chronic complaint by engineers that their work is not properly appreciated and understood by the public. It is idle to dream that through some fortuitious combination of circumstances the public will suddenly awaken to find what important service the engineering profession is rendering. The work and accomplishments of the profession, and even individual engineers, will be given the proper place in the press, if the profession will but do itself justice by furnishing the data.

Yours truly,
P. M. Sauder*

"Engineers Must be Prepared for Hard Knocks"

Victoria, B.C., March 25, 1914.

Editor Contract Record:

In respect of the editorial, "The Organization of Engineering Interests," published in your issue of March 4, I beg to offer you my views, which are the outcome of twenty-six years' experience—obtained mostly in Western Canada.

The organization of "a controlling body or central committee" would be dependent upon other factors, which must be first considered before arriving at the end in view, and the personal equation would appear to be the starting point in any scheme for re-organization. It has always appealed to me that the present lack of cohesion and the weakness of the engineering profession in Canada has been attributable not so much to lack of organization as to (1) the apathy and lack of pride in their profession amongst our individual members of the "rank and file"; (2) the system under which our governing Council is nominated and elected, and (3) the preponderance of University methods and theories in handling the business of the Society.

With regard to No. 1, I think you will agree that in the various branches of all societies, whether professional, benevolent or otherwise, the real work of keeping float and forging ahead is invariably found to be shouldered on to a few of the more energetic members, and the removal of such members often causes a moribund condition to develop, as I have frequently noted in various towns or cities.

The only remedy for this phase of the situation would appear to be a persistent appeal amongst individual members for a higher sense of duty, higher ideals and to awaken each member's pride in the work to be done for the profssion by each individual unit. As an example I will quote an incident brought to my notice recently.

A corporate member of the Society who attended the annual meeting of the Canadian Society of Civil Engineers in Montreal this year, in giving his views of the proceedings, stated that he felt strongly inclined to criticize certain statements made by other members in the discussions but refrained because there were so many members present who were his seniors in age and standing. This member failed lamentably in his duty to himself and his Society through an entirely misplaced veneration for the fetish of "age and reputation"—and his case is doubtless that of many others.

With regard to No. 2, the present method in vogue of electing a nominating committee and the selection of officers by them has tended to develop autocratic rather than democratic government in the Society. As a result we have a Council containing a majority of men usually eminent in the profession, but too busy to get in touch with the human element of the membership at large, and practically acting as "sleeping partners" in the firm with the Secretary as "working partner."

The position of Secretary, being, in my opinion the keynote of the structure, should be held by a member who would devote his entire time to the work at an adequate salary, and his selection should be governed by a wide experience on practical engineering work from the bottom rung of the ladder upwards, involving the handling of men under various conditions and in different localities—in short a man thoroughly versed in human nature, and that knowledge no confined to any one province or district.

Taking up No. 3 there appears to be a growing idea in the public mind (and also to some extent in the professional mind) that a college course turns out a finished engineer, regardless of practical experience. As a matter of fact a college course cannot take the place of experience, but gives the recipient a much better opportunity to become a successful engineer by reason of the study wherewith he has charged his mental battery.

The present system of election to the Society is also defective, as an unmarked ballot counts for the affirmative vote, which renders it unnecessary for those balloting to even read through the ballot. If the word "aye" or "nay" had to be written opposite each name to render a ballot effective, it would at least put each Councillor under the obligation of turning over the pages before mailing to headquarters.

I fear my "views" have run into overmuch space. I can only say in conclusion that we must break loose from the "mutual admiration attitude" mentioned by Mr. Shenton in his address upon which your editorial was based. This attitude we must be prepared to take and give the hard knocks which always accompany genuine reformation.

Yours truly,
R. W. Macintyre, M.Can.Soc.C.E.

Reinforcement of Concrete Floor

Editor Contract Record:

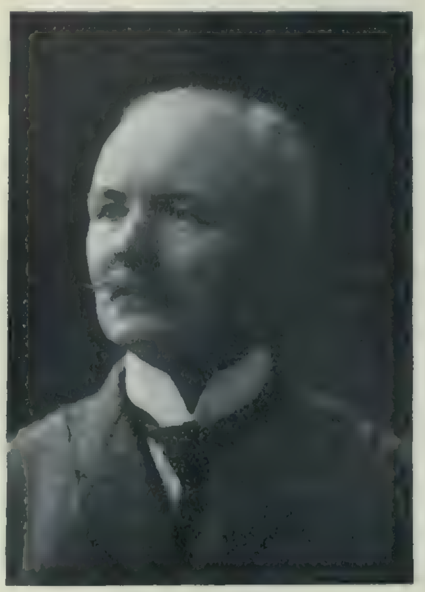
Will one of your readers kindly give a detailed method of finding the reinforcing necessary in a six-inch concrete floor, designed according to the Ontario Government Specifications for Highway Bridges 1911. Span of slab to be three feet.

A Reader.

Surveyors have been at work for some time in the interest of the Canadian Northern Railway Company, deciding upon possible route for the construction of an electric road from Guelph through Hespeler, Preston, Galt and Brantford. A similar survey was made a year ago from Guelph through Mosboro' and Breslau to Berlin.

---

*Secretary-Treasurer Calgary Branch, Canadian Society of Civil Engineers.



Col. W. M. Davis.

Messrs. Davis and Leslie, in consulting practice at Vancouver, who were recently appointed engineers of the North Fraser Harbor Commission.

Mr. R. F. Leslie, M. Inst. C. E.

Personal Mention

Mr. George Morgan Kennedy, a Toronto contractor, who died on February 27, left estate valued at $23,954.

Mr. J. H. Haffa has opened an office for the practice of architecture in the Peterkin Building, Bay Street, Toronto.

Mr. James Sheppard, of Queenston, has received an appointment as superintendent of good roads in Welland County.

Mr. Ward Carlee has been appointed City Engineer of Swift Current, Sask., in succession to Mr. Geo. D. Mackie, who is now city engineer of Moose Jaw.

The candidates for Controller of the city of Montreal include Mr. Percival St. George, consulting engineer and former city surveyor, and Mr. A. V. Roy, C.E.

Mr. Frank Drayton, president of the Amateur Baseball League, has been appointed secretary-treasurer of the Edmonton Builders' Exchange, succeeding Mr. John McPherson.

Mr. Thos. W. Lamb, architect, New York City, has removed his Canadian office from Loew's Theatre, Toronto, to the Stair Building and has placed Mr. A. H. Harding in charge.

Messrs. S. B. Coon & Son, architects, Toronto, have removed from the Temple Building, to more commodious quarters in the new Ryrie Building, at the corner of Yonge and Shuter streets.

Mr. A. M. Jeffers and Mr. W. A. Wheeler have been appointed architects of Edmonton under the city engineer's department. Mr. Jeffers' salary is fixed at $275 a month and Mr. Wheeler's at $160.

Mr. L. G. Stuart, of the Toronto Roadways Department, is arranging for an extended trip through Europe with the object of studying transportation facilities in the principal cities, and European municipal methods generally.

Sir Thos. Shaughnessy, president of the C. P. R., will be the guest of the city at a banquet on the occasion of the opening in May of the Hotel Pallisser, which is in course of completion for the Canadian Pacific Railway at Calgary.

Messrs. Davis & Leslie, consulting engineers Vancouver, have been appointed by the North Fraser Harbor Commissioners as their engineers, and will have charge of the preparation of places for the future development of the North Arm of the Fraser River, which it is anticipated will provide for a harbor scheme of an important nature. The North Arm of the Fraser River diverges from the South Arm at New Westminster, and flows in a westerly direction, entering the Gulf of Georgia in the vicinity of Point Grey. It forms, therefore, the southern boundary of what is known as Greater Vancouver, its approximate distance from the centre of the present city of Vancouver being about five and a half miles. The Harbor Commission's jurisdiction covers the whole of the North Arm from the western boundary of New Westminster to Point Grey, a distance of about 17 miles and also includes the adjacent waters of the Gulf of Georgia over what is known as Sturgeon Bank. Messrs. Davis & Leslie are the appointed representatives for British Columbia of the well-known English engineering firm, Sir Douglas Fox and Partners, and are themselves both highly qualified engineers, with practical experience covering a period of over thirty years. Colonel W. M. Davis, who is a member of the Canadian Society of Civil Engineers, graduated from the Royal Military College at Kingston in 1880 and has been associated with many important undertakings both in Eastern Canada and British Columbia. Among other works in Ontario he was responsible for the Berlin sewage disposal plant. He occupied the office of City Engineer of Prince Rupert from 1910 until 1912 and for the last two years has been in consulting practice in Vancouver. Mr. R. F. Leslie, commenced his practical engineering work in 1881, as an articled pupil in the service of the Great Western Railway, England, and has had wide and continuous engineering experience in various parts of the world ever since, specializing in railway and harbor work, both in England and abroad. For many years he held responsible positions on one of the largest systems in India, and as a senior divisional engineer had charge of much important construction. During the last nine years he has been engaged in railway and harbor work in Canada. Mr. Leslie became an Associate Member of the Institution of Civil Engineers in 1891 and was transferred to the class of Member in 1901. He is also a member of the Canadian Society.

Col. Pilkington, chairman of the directors of the Pilkington Brothers, Limited, St. Helens, Eng., and Toronto, Ont., died on the 15th ult. at Cannes. The late Col. Pilkington had been actively identified with the firm for fifty-six years.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

A factory has been erected in St. John, N.B., for the manufacture of aerated waters.

The city of Quebec is having plans prepared for a fire station to involve an expenditure of $135,000. Mr. W. D. Baillarge is the architect.

Dominion charter has been granted the Interprovincial Brick Company of Canada, Limited, Montreal, to manufacture ceramic ware of all kinds.

The ratepayers of St. Catharines, Ont., will soon be asked to vote on a bylaw for the construction of a new High Level bridge which is projected for the city.

The parish of St. Roch, Quebec, P.Q., are contemplating the erection of a new church estimated to cost $250,000. Tenders will be called shortly by the architects, Messrs. Talbot & Dionne.

It is stated that Mr. Albert I. Jacobs, of Brantford, is negotiating for the purchase of the old Defiance Iron Works at Chatham, and that he will establish a factory for the manufacture of farm machinery.

St. Lambert, P.Q., is undertaking extensions to the waterworks and sewerage systems at a cost of $480,000. The work is scheduled to start a month from date. The Town Engineer is Mr. E. Drinkwater.

Welland County Council has decided to build thirty-four miles of good roads this year by contract, in addition to the mileage constructed by the three county outfits, which it is estimated will total twenty miles.

The third of six scows was launched recently from the yards of the Polson Iron Works for the Montreal Harbor Commission. It is 144 feet long, 31 feet wide and has a capacity of 500 cubic yards, with seven pockets. The six scows will cost $140,000.

Messrs. F. J. Mark Construction Company, of Birmingham, Alabama, are the general contractors for a factory building estimated to cost $250,000, to be erected in Toronto for the Ford Motor Company of Canada. The architects are Messrs. John Graham & Company, Detroit, Mich.

One hundred and fifty thousand dollars is the estimated cost of a Roman Catholic cathedral at Prince Albert, Sask., for which tenders will be received until the thirteenth of this month. The building will be of sand and brick construction. Mr. A. Graham-Creighton, of Prince Albert, is the architect.

With the object of urging important changes in the plumbing bylaw of Hamilton a deputation waited on the Board of Control recently and suggested a number of alterations and additions so as to bring plumbing up to the standard of other cities. The Board promised to deal with the matter at an early date.

A new school is to be erected at Walkerville, Ont., at a cost of $60,000. It is designed for a 17-roomed school, but only the centre portion of nine rooms will be erected at the present time. This will be 62 ft. by 102 ft. and will consist of two storeys and basement. It will be of fireproof construction, solid brick and tile lined brick walls; the floor being hollow tile and reinforced concrete. The exterior will be faced with pressed brick and trimmed with Bedford limestone. Plans were drawn and specifications prepared by Messrs. Kinsey & Chapman, architects and engineers.

Two public schools at a cost of about $200,000 each are to be erected by the Board of Education on a site north of Danforth Avenue, Toronto, and a technical school for the east end at an outlay of about $400,000 will be erected north of Danforth Avenue. The sites, buildings and equipment will aggregate about $1,000,000.

The announcement is made that in addition to the factory at Coldbrook, N.B., where the Ford Automobile Company will this year begin turning out cars, the recently organized Dominion Motor Car Company will take steps to erect a plant. It is likely the company will make St. John their manufacturing and distributing centre for Canada.

From the annual report of the city engineer of St. John, N.B., we learn that the total length of pipe lines of the city's waterworks system is 83.8 miles, while the sewerage length is 43.1 miles. In the city 9,647 lineal feet of pipe were replaced at a cost of $21,861 and 7,019 feet laid at a cost of $20,827. New sewer pipe to the extent of 8,384 feet was laid.

The Canadian Stewart Company have a large quantity of machinery and piles on the ground ready to commence work on the Toronto harbor improvements. All water lots east of Woodbine Avenue which are to be used in the harbor improvement plan and for which an expropriation by-law was passed by the City Council recently have been taken over by the city.

The negotiations between Messrs. T. McAvity & Sons, Limited, and the city council of St. John, N.B., with reference to the establishment by this company of an iron and brass manufacturing plant involving an ultimate expenditure of two million dollars, have proceeded so satisfactorily that the company expect to be able to begin work on the site of their new plant in the spring.

A new industry which promises to become one of the leading in the Maritime Provinces, has recently been started at Newcastle, N.B., by Mr. E. G. Hedman, of Rosebank. The business is the manufacture of weighing scales for which Mr. Hedman holds patents in fourteen countries. Mr. Hedman intends to form a company and erect a large factory, and the new works are expected to be located at Newcastle.

Plans prepared by Mr. J. P. Haynes, architect, Toronto, have been accepted for the erection this summer of a new parochial building to be known as Congress Hall, at the corner of Dorchester and St. Alexander streets, Montreal. Tenders are now being invited for the building, which will be four storeys and basement, of fireproof construction, with steel columns and girders. Montreal limestone will be the material largely used in the structure.

An investigation conducted by Judge Denton concerning the recent fire in the Woodbine Hotel, Toronto, and its relation to the city architect's department, revealed the fact that the building was not constructed in accordance with the building by-law, which requires that all hotels more than thirty-five feet high should be of fireproof construction; that the only fire escape in the annex could be reached only through a bedroom, the door of which would be normally locked, and that the building permit did not specify a fireproof building and therefore did not comply with the building bylaw.

Mr. W. S. Calvert, ex-M.P., of Ottawa, a member of the syndicate of British and Canadian capitalists interested in the development of the oil shales in Albert County, visited St. John, N.B., recently. In an interview he said the details of development could not be given out as yet, but it looked as if the plans of the syndicate would be of great importance to St. John, as oil and gas could be brought to the city by pipe lines. Mr. Calvert added that a definite announcement regarding the development of the property would be made in a short time. Having spent two weeks on the property in company with expert engineers he is convinced of the great value of the deposits.

An important announcement in connection with the Government good roads project was made recently by Hon. Mr. MacKenzie at Sherbrooke, Que. He stated that contracts for the Sherbrooke highway will be let shortly and that the road will be finished this summer. The next road to be undertaken will be a highway from Quebec to the Intercolonial boundary to connect with the new English system at Jackman, Me. Subsequently the government would commence the construction of the Quebec to Montreal road, via Richmond. The work of all these projects will be carried on as speedily as possible and the roads will be equal to any on the continent. Wherever possible, wooden culverts and bridges will be replaced by iron, steel and cement. The government, he stated, was bound in honor to carry through its good roads policy and was anxious to help all municipalities in need of aid.

WESTERN CANADA

Robertson Presbyterian College Board, Edmonton, are raising funds for the erection of a new college building estimated to cost $150,000.

Messrs. Doyle, Thomas & Christiansen, who have the contract for the Allan Gray school in Edmonton, have started work on the building.

Regina ratepayers have approved a bylaw to raise $170,000 for the construction of storm water sewers. Mr. F. McArthur is the city engineer.

At Calgary, Alta., tenders are about to be called for a six-storey Industrial Housing building, estimated to cost $250,000. Mr. A. Pirie is the architect.

Members of the school board of Edmonton are planning to erect this year an Administration Building, to cost $250,000. The structure will be located on College Avenue.

Port Arthur is planning the erection of a new Roman Catholic Church, estimated to cost $140,000. The Bishop of the district is the Right Rev. D. J. Scollard, of North Bay.

Extensions to the electric lighting and power system of Regina, Sask., are to be made at a cost of $160,000. Mr. E. W. Ball is superintendent of the lighting and power department.

Mr. N. A. McIvor, building inspector of Edmonton, reports that this season gives every promise of being characterized by the erection of more substantial buildings than in 1913.

Mr. Jeffers, City Architect, is preparing plans for the erection of a municipally-owned swimming bath in Edmonton. The pool will be 56 by 150 feet, with a maximum depth of 8.6 feet.

Twenty-five applications were received recently by the city council of Kamloops, B.C., for the position of City Engineer. The final choice lay between Messrs. F. W. Anderson, E. Kingwell and C. Collingwood, all of Kamloops, and Mr. Kingwell was elected to the post at a salary of $1,800 per year.

Plans have been completed for a new building, estimated to cost $125,000, for Calgary University, and tenders are about to be called. The architects are Messrs. Hodgson, Bates & Beatty, of Calgary.

Mr. Robert Moore, proprietor of the St. Elmo Hotel, Edmonton, has received plans for a hotel building, costing $300,000, to be erected on the site of the present structure. Work is to begin this month.

English-speaking members of the R. C. Church in Edmonton are planning to erect an edifice to cost $100,000. It will be known as St. Joseph's Church and situated in Eleventh street. Work is to begin this spring.

The waterworks system at Regina is to be extended under the terms of a bylaw carried by the ratepayers. Mr J. W. McKay is superintendent of the waterworks, and the cost of the undertaking is placed at $360,000.

Three hundred thousand dollars is the estimated cost of a ten-storey hotel building to be erected by Mr. Nat Bell, proprietor of the Pendennis Hotel in Edmonton. The hotel will be built of steel, pressed brick and terra cotta.

The building committee of Robertson Presbyterian College has decided to erect a theological building, costing $150,000, on the grounds of the University of Alberta, in Edmonton. It is to be ready for the 1915-6 term.

The Hudson's Bay Company, of which Mr. A. E. Dodman is general manager, is making extensive improvements at its big store in Edmonton. The most important is the display window arrangement in Jasper avenue and Third street.

Mr. G. W. Fuller, manager of the G. A. Fuller Company of Winnipeg, reports that work on the superstructure of the Arts building for the University of Alberta in Edmonton will begin early in June. The structure will cost about $500,000.

Plans for a two-storey store and apartment building for Wilkinson Brothers have been received by the Builders' Exchange, the block to be erected at the corner of First street and Vermillion avenue. Mr. James Henderson is the architect.

Messrs. Dalton and Gardiner are having plans prepared for a five-storey warehouse, 100 x 130 feet, to be erected this year on the Hudson's Bay reserve in Edmonton. Foundation and walls will be of maple dimensions to carry three additional floors.

Messrs. Olson & Johnson have started cement work on the McLeod Building, for which the steel work was completed last fall. The city of Edmonton has loaned $350,000 to the owner to complete the structure, which will be the highest in Edmonton.

Plans have been prepared by a Vancouver firm of contractors for a six-storey mercantile establishment in Edmonton, costing about $800,000. The building is to be occupied by the James Ramsey Company's department store, now housed in the Tegler Building.

There is a possibility that the well-known English firm of Doultons will start a china clay factory in Canada. A member of the firm is at present on his way to South Alberta for the purpose of examining the china clay deposits in that part of the Dominion.

Mr. George Pearson, a capitalist, of Warwick, Eng., announced in Edmonton on March 20 that his plans for this year include the erection of a ten-storey business and office building, costing $600,000, and a theatre building with a seating capacity of 2,500, estimated to cost $400,000. The structures, upon which work will begin within the next sixty days, are to be situated in Second street, the last named adjoining the Empire hotel.

Realizing the necessity for the provision of harbors of refuge on the Great Lakes, Hon. Robert Rogers, Minister of Public Works, has undertaken to send departmental engineers to the Bruce County Shore on Lake Huron, to investigate harbor possibilities at Inverhuron.

At Edmonton, Alta., operations have been renewed on the erection of a ten-storey store and office building of terra cotta and pressed brick construction estimated to cost $450,000. The architect is Mr. J. K. Dow and the general contractors are Messrs. Olson, Johnson Company.

The city of Calgary, Alta., will require three-quarters of a million dollars in cash to carry on its various works and municipal activities within the next three months. Amongst the items decided on is that of $100,000 for a paving plant, $125,000 for electric light and power and $50,000 for waterworks improvement.

Civic improvements, involving capital expenditures of more than $2,400,000, will be submitted for approval to the ratepayers of Edmonton on April 6. The city council has passed these expenditures and others to the amount of $7,456,872, of which $2,099,667 is to be set aside as a working capital. Three million dollars will be expended upon street, sewer and similar improvements.

The Bank of Alberta, recently incorporated under a Dominion charter, will expend $250,000 in the construction of a modern bank and office building in Edmonton, according to an announcement made by Mr. E. S. McQuaid, solicitor and a member of the directorate of the bank. The new building, to be used as head offices of the bank, will occupy a prominent site in the business district.

Announcement was made recently by the Hon. Geo. E. Foster that legislation will be introduced shortly to give the grain commissioners more control of the grain elevators from Fort William to the ocean. For the construction and operation of terminal and interior elevators a vote of five and a half millions was made, and Mr. Foster stated that interior elevators would be constructed at Saskatoon, Moose Jaw and Calgary, a transfer elevator in British Columbia and an elevator at Hudson Bay, the two first-named elevators to be ready this season. The tenders of Messrs. Barnett and McQueen for the erection of the Saskatoon and Moose Jaw elevators at $2,500,620 was accepted by the government. Plans are in course of preparation for the Calgary elevator.

Mr. H. C. Drake, engineer in charge of construction, recently gave particulars of the oil refining plant to be located near Port Moody, B.C., by the Imperial Oil Company. Preliminary work will be commenced shortly pending the arrival of the steel for the tanks and the completion of the spur line from Port Moody. There will be thirty-five tanks altogether, three of which will be 93 feet in diameter and 35 feet in height, with a capacity of 200,000 gallons each. A wharf 750 feet long with an "L" branch will be built out to deep water for the accommodation of the big oil tank steamers which will bring fuel from California. A large pumping station for discharging the cargoes from the tankers into the reservoirs and transferring the crude oil from one section to the other during the refining processes, will be provided. The plans which have been prepared by the Imperial Oil Company, provide for the gradual expansion of the refining plant as the business in the west grows.

There appears to be a difference of opinion between the Premier of British Columbia and the Burrard Inlet Tunnel and Bridge Company as to the cost of building the Second Narrows bridge. Some time ago the government declined to give the company further aid in connection with the original request of the directors that the authorities at Victoria take over the whole project and construct the bridge themselves. The government also declined to provide a guarantee for a bond issue of $750,000, claiming that its grant of $400,000 was sufficient at the present time and pointing out that as the bridge company was short of having sufficient to complete a $2,500,000 structure as provided for by the Wolfe-Barry plans, it should go ahead with a cheaper bridge. Plans for a bascule type bridge were prepared for the government by Mr. P. C. Moss, formerly engineer in charge of the bridges built for the city. According to his plans a bascule bridge could be constructed across the Inlet at the Second Narrows at a cost of $1,500,000, as compared with $2,500,000 for the somewhat larger bridge provided for by Sir John Wolfe-Barry. The bascule bridge would have spans of forty-four feet, centre to centre of trusses, and provide for two railway tracks, each with overhead trolley wires, which would give continuous and uninterrupted traffic of trains and electric cars in both directions at the same time. In addition there would be a 16-ft. roadway for vehicular traffic. Outside of the truss is an 8-ft. sidewalk for pedestrians. The overhead clearance is forty-five feet from the surface of the water at high tide to the underside of the spans over navigable water. The movable span is a bascule of the Heel trunnion type, rotating upward from the main trunnion (short shaft) in journal bearings secured to the end of the supporting span, being exactly balanced in all positions by the concrete counterweight which rotates downward through the same angle as the span. The bascule span and counterweight are connected by a pivoted link which moves parallel to the end post of the supporting span. A small latch is drawn and the simple movement of raising commences and vice versa after the vessel has passed. The span is latched to the pier when closed by a 5 h.p. motor. All the piers are designed to be of concrete.

Canadian Railroad Development

Regina's street railway system is to be enlarged at a cost of a quarter of a million dollars.

The C. P. R. contemplate the double-tracking of their line from Port Arthur to Sudbury at a cost of $6,000,000, from Calgary to Brandon at a cost of $5,000,000, and from Revelstoke to Vancouver at a cost of $7,000,000.

The foundations for the new one-million-dollar hotel which the Grand Trunk Pacific is erecting at Regina are complete and work will be resumed about the middle of this month. The architects are Messrs. Ross & MacDonald and the contractors the Lyall, Mitchell Company.

Messrs. Westinghouse, Church, Carr & Company, of Montreal and New York, are the engineers who have been retained by the Canadian Pacific Railway, in connection with the proposed double-track, six mile Selkirk tunnel in British Columbia. The investigations, which will be of a preliminary character, are expected to cover in general the relative colonies of steam and water power, the effect of the electrification upon operating conditions.

In preparation for the establishment of docks for ocean-going vessels and railway terminals at Squamish, the Pacific Great Eastern Railway intends to proceed with the reclamation of an area one mile in extent during the coming summer. In an announcement made recently in which Mr. G. W. Stewart, president of the company, outlined their plans for development and construction, he pointed out that when the work on all the new sections was under way employment would be provided for more than 12,000 men.

Montreal's Building Programme

As far as can be judged at this early date, the building programme in the Montreal district should be fairly important. Within the last three years, many office buildings have been erected, and for the present the demand in that direction has been about met, so that little work of that character will be carried out during the season. Some buildings started last fall will have to be completed and this will provide a moderate amount of employment. The new custom house is probably the largest individual job to be executed, while contracts for several churches, schools, theatres and factories will be let. The greatest requirement of the city, however, is additional residences, to house the increasing population. Small residences and flats are in very short supply, and there is a pressing demand for these —a demand which last year was not really satisfied. Rents have risen in every part of the city, and yet houses were rented before they were erected. The great majority of the permits taken out this year are for residences, a significant feature being the number of eight and ten-storey apartment houses to be constructed. There are indications that the workmen will try to enforce a considerably higher scale of wages; the employers will probably be willing to make concessions to some classes, but trouble will follow should the men unduly press for wages and hours which conditions do not warrant.

Industrial Enterprise in the Maritime Provinces

An outstanding example of industrial activity in the Maritime Provinces is to be found in the enterprising policy of the Standard Clay Products, Limited, whose chief offices are situate at St. Johns, Que. The latest addition to the company's operations is a new plant located at New Glasgow, N.S., which is claimed by them to be the largest sewer pipe plant in Canada. It is equipped with machinery of the most modern and up-to-date type as the following list of makers will show:—Two Stevenson sewer pipe presses, two 9-ft. Stevenson dry pans, four 8-ft. Stevenson wet pans, a 400 h.p. Goldie & McCulloch engine, and four 18 ft. x 6 ft. Matheson boilers. The plant also includes an electric light engine and dynamo, as well as motor driven and gravity power elevators. The equipment comprises dies for the manufacture of sewer pipes from 4-in. to 30-in. diameter. Ten kilns each of 34 ft. capacity have been erected, while five more are to be installed this spring.

View of plant No. 3, New Glasgow, N. S. Standard Clay Products, Limited.

The company owns seventy acres of clay and shale lands at New Glasgow, with shale beds about 60 ft. thick above drainage, and extending about 1,000 feet in depth. These beds contain several hundred millions of raw material for the manufacture of clay products. In addition to this plant the company is operating another sewer pipe plant about 300 yards distant, which latter was established in 1904. The principal lines manufactured by the company comprise salt glazed, vitrified sewer pipes, culvert pipes and sewer pipe connections of all descriptions, hollow building blocks, chimney tops, inverts, vases and all kinds of vitrified and fire clay ware.

It will be remembered that the firm's No. 2 plant at New Glasgow was partially burnt down on March 12. However, the work of reconstruction is proceeding rapidly and in the near future everything will be in working order as before. The operations of the Standard Clay Products, Limited, are very far-reaching and the facilities for output will be greatly added to by the new factory at New Glasgow, an illustration of which appears with this notice.

Mr. Walter C. Allen has been elected vice-president and general manager of the Yale & Towne Manufacturing Company, New York, Mr. Allen entered the service of the company in a minor capacity in 1901 and has risen from the various manufacturing and administrative departments to the responsible position he now holds.

The business of the Tungstolier Company of Canada has been taken over by the Canadian General Electric Company, Limited. It is the intention to carry in stock a large assortment of electric fixtures for both commercial and residential lighting. Communications regarding fixtures and glassware should be addressed to the Canadian General Electric Company, Limited, Fixture Section, Toronto, or to their nearest district office.

An interesting booklet received from Messrs. Bechtels, Limited, Waterloo, Ont., deals with a line of steel dump cars and industrial railroad equipment manufactured by this firm. The various types of car are described in detail, the dimensions being given very carefully in each case. It is pointed out that for general use in brick yards, contracting work, sand pits, and even in mines, the side dump car offers many advantages over other styles, while the bottom dump car has the claim to preference for the transportation of bulky material. The Bechtel rotary scoop car and the Bechtel gable bottom car are among other types featured. In addition to the dump cars various other equipment is described, such as turntables and portable track.

The B. F. Sturtevant Company of Canada, Limited (919 New Birks Building, Montreal) have an encouraging list of recent contracts which are now being executed at their plant in Galt, Ont. Upon looking through this list we find that ventilating apparatus has the place of honor, the contracting for such having been made for the Dandurand Building, St. Jean L'Evangelist School, Drummond Building, Longue Point School, the Shawinigan Water & Power Company's building, the Poupart Street School and the buildings of the National Breweries, Limited, who are said to have the best ventilating apparatus in Eastern Canada installed in their new stables. Continuing through the list we find that the Sturtevant Company have the contract for a large variety of other equipment, such as rolling mill equipment, cotton conveying apparatus, fans, induced draft apparatus and equipment for a new forge shop. These facts indicate that the Sturtevant Company is able to furnish the Canadian trade with the right goods at Canadian prices.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **April 8, 1914** **No. 14**

Principal Contents

The Curtain Raised on Toronto's Fire Tragedy 411
What Concrete Will Not Stand 412
By the London (Eng.) Correspondent of the Con-
Engineering Topics in the Old Land 413-4
tract Record.
The Double-Track Tunnel of the C. P. R. through Mount Macdonald, B. C. 415-7
Forms for Concrete Work 417
Progress on the Quebec Bridge Construction 418-20
Self-Anchored Suspension Bridge at Cologne 421-3
Operation of Small Rapid Sand Filters 423-6
Small Sewage Pumping Plants 427-8
By S. A. Greeley and Langdon Pearse
A Practical Discussion of Waterproofing Problems.. 428-30
By L. G. Mauer
C. P. R. High Level Bridge at Edmonton 430
How Bridges Expand 430
Materials and Methods in Producing Satisfactory Road Carpets 431-3
By Major W. W. Crosby
Economic Design of Standpipes and Conduits 433
The Bank of British North America's New Building at Montreal 434
Mechanical Filtration 434
Increased Activity at Vancouver, B.C. 435-8
Personal Mention 438-9
Constructional News 439-42

The Curtain Raised on Toronto's Fire Tragedy

In our issue of March 25 we commented briefly upon the fire hazard and its responsibilities in connection with the fire at the Woodbine Hotel, Toronto, which resulted in the death of five persons. At the time we refrained from criticising any of the interests concerned on the ground that an investigation was being held. We condemned the public disposition to pass hasty judgment in such matters and censured the daily press for their gratuitous reflections upon those who were in any way related to the work of erecting the building. This we felt constrained to do in the interests of common justice. Now in these same interests we are constrained to make some comment upon the findings of Judge Denton, whose report upon the City Architect's Department of Toronto was submitted to the Mayor last week.

While the disaster at the Woodbine Hotel is a side issue of the report, the tragic occurrence makes the findings additionally interesting. It is as if the curtain were raised on the closing scene of a tragedy, revealing the actors in their several parts. Here it would appear to be an all-star cast with parts of equal responsibility played by the city's officials, controllers and other members of the local administration. A lamentable feature in connection with the spectacle is that apparently there is not one redeeming character among the personnel—not one whose part is to uphold the right.

It is an old, old plot, with the public as the victim, but the story is new in respect to its absolutely sordid character. It is a revelation not of incompetency alone, but of discrimination and graft,—immorality in its worst form. It is a disclosure of the same low standard which has earned for the United States the unsavory notoriety of having had the dirtiest administration in the world. The comment is strong, but in reality it is wholly inadequate to the occasion. The limited vocabulary of the English language is kind to those who juggle with public property and human lives in one hand and personal gain in the other—and this is what is revealed by Judge Denton's report.

It is shown that discrimination has been rife in the City Architect's Department and that the Woodbine Hotel construction was only one instance of the latitude allowed by the officials. The hotel addition did not conform to the requirements of the bylaw in any respect. While the bylaw provided that buildings exceeding 35 feet in height should be fireproof, an addition 42 feet high was built of ordinary joist construction, approved by the Board of Control and a permit issued when the work was almost completed. In the first place permission had been given to change stores into a hotel. Later, a factory building in the rear was acquired for an addition to the hotel, for which, we are told, a "tentative" permit—whatever that may be—was secured. That there were inner bathrooms in the addition is a detail, and it is of comparatively minor importance that one fire escape was provided in the rear, access to it being possible only through a bedroom.

If one accept the findings of the report it is impossible to urge reform. It is shown that controllers, aldermen and public servants have abused the public trust, that they have shown discrimination, accepted bribes and used their offices for the advancement of purely personal interests. Employees of the Architect's Department have accepted fees for making plans which, afterwards, for a further consideration, were approved either by themselves or by their coconspirators (it were a misnomer to say colleagues—a colleague, as generally accepted, being an associate with another in an honorable undertaking).

We say that it is impossible to urge reform, because in view of Judge Denton's findings we regard the five lives lost in the Woodbine Hotel as having been a direct sacrifice to the cupidity of the city's administration and its satellites. To reform is to fashion anew, to amend, to reclaim. What is needed is not a house-cleaning but a new structure.

We are thoroughly in accord with Judge Denton's recommendation that the present City Architect's Department should be abolished and be replaced by a separate branch of civic government—known, perhaps, as The Department of Buildings. We might go a step farther and urge the removal from office of certain members of the Board of Control and Property Committee the majority of whom are ignorant men totally unqualified to discharge their duties. This we should do if we were pressing for justice on behalf of the relatives of those lost in the Woodbine fire. But we are not. Our viewpoint is an altogether wider one. We are concerned with the efficient administration of all matters constructional in which the public safety is involved. As a personal matter we hold the opinion that to retain in office the officials who figure in Judge Denton's findings would be an unmitigated outrage of all the canons of public decency. But our observations must not be mainly personal, but in the main impersonal.

For years the city of Toronto, the greatest building centre in the wide Dominion, has been carrying on its constructional activities under the most deplorable conditions. There is a modicum of consolation in the reflection that perhaps, after all, the Woodbine Hotel disaster may hasten the work of re-organization. For years Toronto builders have been carrying on their operations according to a code the terms of which, until quite recently, were opposed to all good practice. The shortcomings of the by-law as it now stands were shown in the able report recently submitted to Judge Denton by Mr. C. R. Young, Assistant Professor of Structural Engineering in Toronto University.

It has remained for Judge Denton to give the city the basis for a complete re-organization. It remains for the city to act on the spirit of the recommendations. No other course can be pursued by any self-respecting community.

It is not difficult to see that some of Judge Denton's recommendations have been inspired by experts. Some of the suggestions made are particularly commendable—such, for instance, as having plans examined by men specially qualified in each case to deal with the various types of construction. The importance of adequate inspection is very properly emphasized and a proposal to increase the scale of fees may be endorsed on the ground of giving much and expecting much. A recommendation which we endorse most heartily is that the building bylaw should be carefully considered by the new head of the department with a view to its revision, in order that while preserving the necessary margin of safety any unnecessary cost of building may be avoided.

We repeat that it is inconceivable that the city of Toronto, one of the most important constructional centres in America, should continue to nurture in office men who are content to see her progress restricted by regulations which bear throughout the impress of ignorance—men who subordinate public interest to personal enrichment; men who are content to remain inactive in face of the certain knowledge that the Toronto building regulations afford the ridiculous anomaly of being so excessive in their requirements on the one hand that they entail an annual loss estimated by Professor Young at nearly a million dollars and on the other hand so lax and easily over-ridden by controllers, property commissioners and their friends that forms of construction are permitted which invite disaster and court death.

What Concrete Will Not Stand

PRACTICALLY every failure and near failure in concrete has been due to confidence on the part of somebody that concrete can surmount all manner of bad usage, comments Engineering News. The fact is that there are plenty of good standards in concrete design and in concrete construction, but that they are not observed by many of those engaged in concrete building.

This neglect has a three-fold cause: ignorance, undue economy and over-confidence—and the first two could not exist were it not for the last. It is a pretty poor concrete man who does not know that frozen concrete will not set—but there are plenty who will take a chance with ten-day concrete at 40 degrees F. if they need the forms. Why? Primarily because they want to save the money that an additional set of forms would cost. But if there were not confidence that the concrete will stand up, the pocket book would not govern judgment.

Practically every designer of concrete buildings will admit that 850 pounds per square inch is too high a stress in the concrete beams over the room where his own family sits down to dinner, but he is not so worried about that stress when it is in someone's garage. He feels confident that it will not fall down, in spite of tests which show it to have a low safety factor.

Throughout the whole field this pernicious combination of ignorance and complacency extends; instances might be multiplied almost without end. It is our duty to urge upon the workers in the industry a proper appreciation of the dangers of this over-confidence. Skinning of work is a species of ignorance, for nothing is quite so evident as the fact that good work in concrete construction pays. But the man who thinks he knows more than the so-called authorities is the hardest to reach because he is clad in the nearly impenetrable armor of conceit.

Every concrete failure means a slight betterment in methods, for a certain number of hitherto unconvinced practical or commercial men are shown by that most potent object lesson, a heap of ruins, just what concrete will not stand.

Mr. J. L. Weller, chief engineer of the Welland Ship Canal, was accorded a hearty vote of thanks by a St. Catharines audience recently for his instructive lecture on the progress and scope of the work on the big waterway. Making comparisons with the Panama Canal he pointed out that the Panama locks were 1,000 ft. long, 110 ft. wide and 80 ft. high, with a lift of not more than 30 ft. The lock of the Welland Ship Canal would be 800 ft. long, 80 ft. wide, 82 ft. high and would have a lift of 46½ ft. at each lock. The lock gate weighed 1,100 tons, against 700 tons for the largest leaf of the Panama waterway.

Engineering Topics in the Old Land

A Discussion of the Suggestions Advanced in Regard to the Responsibilities of the Engineer under Lay Administration—Centralization and Decentralization with their Attendant Evils as Exemplified by English Methods—Professional Society Work and Its True Functions

By the London (Eng.) Correspondent of the Contract Record

THE recent correspondence in the Contract Record, "Engineering Responsibilities and Lay Administration," which has followed the leading article on the subject, has a unique interest and importance. Lay administration is a worldwide disease from which every nation is suffering, and it is owing to this very fact of its universality that its ravages escape public notice. By the engineer, however, and especially by the municipal engineer, its evils are keenly felt, and the life of many a man is turned into a miniature Hades b-- the prevalence of numskulls and dummkopfs in the personnel of his Council. The expressions must be taken more or less in a Pickwickian sense. A man may be a very excellent grocer. He may have a perfect genius for bar-tending. But none the less when it comes to the conduct of the affairs of a city or a town his brain may in very truth become torpid, benumbed, dull, and unable to answer the strain placed upon it. He may, as has been said, be a very excellent grocer or bar-tender, but his efforts to get the hang of an engineering problem may well render the epithet "dummkopf" quite applicable, and not a whit more uncomplimentary than the truth usually is. The commission form of Government, executives of higher calibre, organization of the profession of municipal engineering, and the establishment of a Department of Municipal Administration are among the more valuable suggestions put forward by readers of the Contract Record; but there is one still more valuable that appears to have escaped their notice—one that has been mooted by the writer on more than one occasion and has brought much contumely upon his shoulders.

The Evils of Decentralization

Centralization and decentralization both have their attendant evils. In England the decentralization which has followed the introduction of the Local Government Act of 1894, for example, has been productive of very much that is evil. It has resulted (to take one phase of the subject) in the formation of a number of petty little districts, self-governed by local ignoramuses and busybodies and officered by men not one whit superior to ledger clerks and road foremen. The introduction of urban luxuries (to use one of the cant phrases of the local magnates who boss these pitiful shows) has spelt disaster. Rates have gone up to as high as 60 per cent. of rental value, with the inevitable result of a deadlock in building. Road maintenance has degenerated into a "sloppy" farce, sewage-disposal into a "stinking" joke, and refuse destruction into a "malodorous" comedy. There are districts where one individual holds every public post that there is, receiving as petty Pooh-Bah the wage of a navvy' secretary.

A Department of Municipal Administration

The policy of centralization, on the other hand, has kept together an ineptitude such as the Local Government Board, with its red-tape formalities, medical faddisms, and inspectorial idiosyncracies. John Burns did try to do something during his years of office, but the permanent officials were up against him, and from the juniors downwards the spirit of opposition was ineradicable. Class prejudice may account for much, but there was also the hatred for the man who, in such an exalted position, put a shoulder to the wheel himself. Much more honoured was a certain predecessor in office, who would necessitate lengthy journeys by the staff to the Moors and eleswhere when an occasional important document (there **are** such things) required his personal signature. The Local Government Board is, of course, more of a Poor Law than a municipal body, and the pity is that it dabbles in such matters as engineering or sanitation at all. The creation of a Department of Municipal Administration would be as welcome here, in England, as it would be in Canada. England is, however, already in the rut unfortunately, and vested interests will see to it that nothing of a practical nature be done. Canada is still on a comparatively good surface, and it will be her own fault if, with the 'orrible example of the Local Government Board before her, she allows herself to be bogged and quagmired in a similar way. So much for the suggested Department of Municipal Administration.

A Working Triumvirate

Local autonomy must necessarily be preserved in some form or another. "The usual council," says Mr. Macallum, "is generally led by three or four men more or less familiar with city business," and, this being so, why not, he adds, "carry on the business by that number?" The carrying of Mr. Macallum's point to its logical conclusion will place that gentleman on the side of the writer in the daring suggestion to which reference has already been made. The three or four men who are most familiar with city business are the clerk, the engineer and the sanitary inspector. The others simply don't count at all. Mayors, aldermen, chairmen of committees—even medical officers, in the majority of cases—may be regarded as superfluous or purely ornamental. Why not then, to use Mr. Macallum's words, "carry on the business by that number?" To obtain an "executive of higher calibre," by any system of popular voting, is out of the range of practical politics. Selection would lead to "graft" if the offices were to be purely honorary; and the alternative is either the Commission form, which would prove but little better than the present form, or—and here enters the "daring suggestion"—the abolishment of Council altogether. Let the clerk, the engineer and the sanitary inspector act as the local coalition government, the work triumvirate, subject only to the control of the Department of Municipal Administration. At once would the status of all the officers be raised and with increased and increasing responsibility men of higher calibre would enter the profession of municipal engineering, while those already engaged in it would have every incentive to improvement. The organization of the profession would proceed apace, and organization might then have for its primary object improve instead of protection. A system which necessitates men organizing themselves as a protection against the terrible results of doing their duty is sheer idiocy.

The Fallacy of Numbers

The cultivation of the social spirit in the members of a professional society is eminently desirable. Even the most hirsute individual must occasionally unbend, and the wagging of bearded chins in solemn conclave may be agreeably varied in several ways. But there are times and places for everything, and the merry quip and jest which may beguile the tedium of a smoking concert or the enervating dissipation of an "al fresco" luncheon are sadly out of place at an annual convention. Here, there is important work that should be done, and none should pass without some indelible record being placed upon the history of the society. As has been well said editorially, in speaking of the recent annual convention of the Canadian Society of Civil Engineers, "such an event should prove an annual inspiration to every member of the profession." As such affairs go here, in England, the attendance from point of numbers was good, and the visitors did not swamp the members, as was the case at a meeting of a certain Institution in London, when the chairman, the secretary, three members and five press representatives alone were present. The unfortunate fact is that mere numbers do not count for such; it is interest, enthusiasm, self-control and solidarity that are wanted. There is a certain class of man that will speak on everything; there is another class that maintains an obstinate silence on every subject, even upon such as it is most qualified to discuss. There is the man who attends a convention because he feels that he ought to show himself at a meeting now and again, and there is the man who attends merely because he wants a day off. There are even men who really do not know why they do attend, unless it is upon the off chance of shaking hands with a friend or two or doing a bit of business in the town visited What is wanted are men who have the interests of their society sincerely at heart, who regard a meeting as a red-letter event, and whose enthusiasm is not of a day but of all time. These it is hard to find. "While the growth of the society in numbers has been very satisfactory," one reads, "there has been no corresponding growth in the enthusiasm of its members, as evidenced by attendance at the meetings, by the preparation and contribution of papers, or of discussion on the papers submitted, but rather the reverse."

The Premier Institution

This is a gloomy statement indeed; and yet the Society may take heart, for apathy and indifference are the common lot of professional societies the world over, once the early enthusiasm has simmered down. Even the great English Institution of Civil Engineers is devoid of enthusiasm. It works on its bank balance and its record in the years that have gone. It is to all intents and purposes a preserve for top dogs, who from their seat upon the Council hand out jobs to the small fry, who are kept from getting them for themselves by a beautifully balanced system of professional etiquette. An engineer who is not a member (or associate member) of the Institution is practically debarred from a livelihood; hence the guineas annually flung into the funds largely for the behoof of the charmed circle. It would be ridiculous to say that the ordinary member did not get some return for his subscription, but it is beginning to be appreciated very keenly that such return is not commensurate. As to the boasted "Proceedings," the volumes can very shortly after publication be purchased for a few pence each, and the writer now has a set extending over a number of years which will have to go at waste-paper prices shortly if no offer comes along.

"Class" Distinctions

That "nothing succeeds like success" is not true of professional societies. It is success that spoils them. The founders of a society will possibly be men actuated by no thought of reward and acting solely for the benefit of their professional fellows. With increasing numbers the founders become lost to sight. Pushing individuals thrust themselves upwards, and the evil influence of domination begins to be felt. Then cliques are formed, and the whole work of the society falls into the hands of a few, who take in rotation all the posts of honour available. Back-scratching and log-rolling become rife, and the younger men—the men for whom the society was called into being—are cold-shouldered and driven to the wall. Only by encouraging the students and young associates can a society flourish. They are its life-blood, and if the stress fails lethargy and collapse ensue. But the youngsters are bashful and reserved; they lack experience, and they hesitate to express their views. It is just these things that have to be overcome, and it is up to the seniors, the men who have made their mark in the profession, to draw them out. There are many ways in which this can be done, but patronage and condescension are not among them. There must be an equality among all classes in the society, at any rate when assembled at a meeting or in convention, and the younger men must be made to feel, beyond any shadow of doubt, that this is so. The whole practice of "class" distinction is open to condemnation. Professional societies do not differ so much from trading concerns as they perhaps ought to; but facts must be faced as they are, and what honour there once was in admittance has been discounted of late years in more ways than one. Equality within the four walls of a society must inevitably add to its influence for good. Dignity is after all but a very unsubstantial form of diet.

A lecture was recently delivered by Mr. Marconi in Rome before the King and Queen of Italy, members of the Italian Government, both Houses of Parliament, and the Diplomatic Corps. He described the progress which had been made in wireless telegraphy, and the difficulties which had been overcome since his previous lecture in Rome in 1903. His voyage to South America on board the Principessa Mefalda had illustrated that communication in a north and south direction was easier than communication in an east and west direction. Mr. Marconi described his new system for generating continuous waves and its use in wireless telephony. He then described the apparatus for producing waves, divided into regular groups, and dealt with the improvements effected in receivers, giving a practical demonstration of the reception of messages in the lecture hall from Poldhu, in Cornwall, and Tripoli. Mr. Marconi finally described the practical applications of radio-telegraphy to all types of vessels, including submarines, as well as its uses in war and peace. He concluded with an acknowledgement of the help which he had received from the King and Queen of Italy.

The C. P. R. Double-Track Tunnel through Mount Macdonald, B. C.

FIVE hundred men are engaged day and night in constructing the five-mile double-track tunnel through Mount Macdonald, one of the peaks of the Selkirk Range in British Columbia. The bore will be the longest railway bore on the American continent and will obviate the present necessity of using two long spiral loops on the western slope and many miles of snow sheds. The improvements are designed to effect a big grade reduction and the abandonment of one of the most costly section of railway, from an operation standpoint of view, on the entire C. P. R. system.

The new tunnel will shorten the route by four miles. The enterprise is officially known as the Rogers Pass tunnelling scheme, and the work and related improvements will involve the expenditure of more than $10,000,000.

Since the company opened its transcontinental line through the mountains of British Columbia, it has expended millions of dollars in protecting and renewing its tracks, on extra locomotives used to haul trains up the heavy grades, and in coping with snowfalls and other physical handicaps which keep a large force of men and a large amount of expensive equipment busy nearly all the year. At Rogers Pass, close to the summit of the Selkirks, the company maintains large engine sheds, shops, snow ploughs and outfits ready for service on both sides of the Selkirk Range. For many years the railway company has been gradually effecting a reduction of its gradients and improving its main line generally. Four years ago two spiral tunnels were bored through Mount Cathedral and Mount Ogden in the Rocky Mountain range, eliminating what was known in railway circles as the "big hill" between Field and Hector.

The C. P. R. decided on the Rogers Pass tunnel undertaking and relating double-tracking work last spring, preliminary operations having been started in June. Before the work could be commenced on the excavation for the approaches, sidings had to be installed on either side of the mountains, camps established, trails and roads built, and a thousand and one other organization details given attention. Boring operations on the "pioneer" bore were commenced last autumn and a start was made a short time ago on the main tunnel from the eastern portal.

The new location for the line under the Selkirks branches off from the present route near Cambie, three miles west of Glacier, and at a point close to the commencement of the "loops" going west. The camp at the western end of the work is gained by two routes—by following the siding, or by an excellent road built by the Provincial Government, which leads from Glacier House down the valley and passes near the scene of the work. Following an even grade from Cambie the approaches to the tunnel run in an almost straight line to the base of Mount Macdonald. A large amount of excavation has been done and the material originally intended for dump filling has been found necessary for the roadbed.

The western portal will be located about 1,700 feet below and a short distance west of Glacier House. The main passage will provide for double tracks, and the approaches from both ends will also have parallel lines. The tunnel will be 29 feet wide and 23 feet high, space for lining the walls, where necessary, being provided by extra excavation. The inside of the tunnel will be timbered and reinforced with concrete where required. The exact material in the heart of the mountain will only be determined as the boring proceeds, although it is expected that strata of different kinds of rock and earth will be encountered on the way through. Two big steam shovels, one of them scooping up as much as ten tons at once, are to be seen at work in the cutting which will lead up to the portal of the passage. The tunnel will follow a straight line under Mount Macdonald, emerging in the Beaver Valley at a point about 1000 feet below the present line, which reaches the summit by a gradual incline on a route notched out on the eastern slopes. The eastern entrance is situated almost immediately below Hermit, a flag station east of Rogers Pass and nearly 47 miles west of Golden. Up to the timber line a space has been cleared between the trees, posts being planted to mark the path which will be taken inside the mountain. A centre line has been mapped out right up to the top of the peak, on the apex of which is a pole with a signal flag, from which observations may be taken from both the Illecilewaet and Beaver valleys.

Mount Sir Donald—One of the principal peaks of the Selkirks, adjoining Mt. Macdonald.

Mount Macdonald can only be climbed from the west side, as it drops down practically sheer on the western slope. When the signal flag was being planted on the extreme summit, last August, the staffs of engineers at the eastern and western camps sighted their instruments from both valleys and checked up their previous calculations in order to ensure perfect accuracy in projecting their respective bores. The pole at the summit indicates the alignment of the tunnel, while a route surveyed around the slopes of the mountain gives the basis for the triangulation. The exact location of the tunnel will be determined by the two courses mapped out over and around Mount Macdonald and by mathematical calculations. The highest point reached by the proposed tunnel will be 3,795 feet above sea level, or 4,065 feet from the extreme height of the peak. The passage through the mountain will have a gradual rise of one per cent. to the "interior summit." After passing through the tunnel the railway will cross Bear Creek, near the eastern portal, and follow the course of the Beaver River, ascending to Six-Mile Creek, the junction point ten miles east, by an easy grade. Stoney Creek and other mountain streams will be forded close to the base of the slopes.

The contractors for the tunnel scheme are applying an entirely new method in tunnel work, projecting what is known as a "pioneer bore." This is a small preliminary shaft, seven feet by nine, which will parallel the course of the main tunnel fifty feet distant and be bored from both ends at the same time. The idea is in the nature of an experiment and was decided upon only after careful calculation and mature consideration.

The loop approaching the great mountain.

One of the reasons for the adoption of the new plan was the fact that the C. P. R. wished to have the main undertaking finished by December 31, 1916, three years and a half from the time the work was started. With the "pioneer bore," the work will be greatly facilitated. Side drifts will be excavated leading into the course of the main tunnel, and drillers will thus be enabled to attack a number of points at once. While blasting is proceeding in one part of the shaft the workers will be able to continue their activities in another shaft instead of having to cease work each time a shot is fired, as would be the case with the one heading. The same applies to the excavation part of the work. Lines of cars loaded with material can be kept continually in motion from the various drifts, which would not be possible were the operations concentrated at one part.

Another advantage is the fact that the "pioneer bore" will act as a ventilating shaft, enabling the passage of a current of air through two bores and the connecting passages. It will also serve a permanent purpose in the same connection on the completion of the main tunnel.

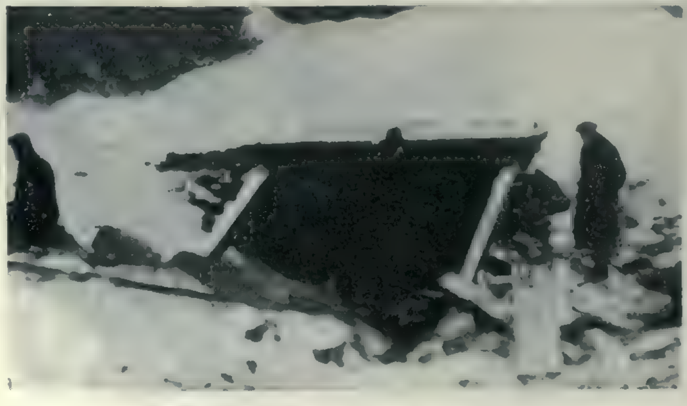
One of the difficult engineering works carried out in conection with the tunnel undertaking was the diversion of the course of the Illecilewaet River. The stream, which during the spring freshets assumes the dimensions of a torrent—presented a great handicap, as its original channel crossed the location for the approaches at a point where a deep cutting had to be excavated to secure the necessary grade for the entrance of the tunnel, and then skirted the route for a considerable distance. While measures could have been taken effectively for carrying the tracks on trestles or bridges, there would still have been the danger of the river encroaching on the line or undermining the roadbed. It was decided, therefore, to change the course of the stream. To accomplish this and to prevent furture trouble, a deep trench nearly a mile long was dug on the left side of the approaches. This will act as a continuation of the original channel of the river, and will divert the stream past the cutting to a point where an arched culvert will turn the water under the tracks again into the old creek bed on the right side of the railway.

The tunnel contract covers eight miles of the improvement scheme, which will extend to Six-Mile Creek, and includes the construction of the line from the junction point at Cambie to a point about a mile on the other side of the eastern portal. A contract will be let later for the double track connections further east.

Model villages have been established by the contractors on both sides of the mountain. The buildings are all equipped with electric light, hot and cold running water, and other conveniences not usually found in the ordinary railway camp. Roomy dining rooms and sleeping quarters are provided for the men, the houses being connected with covered passage-ways raised above the level of the snow. The kitchens are well laid out and appointed, having concrete floors, among other aids to cleanliness.

Comfortable quarters for the clerical and engineering staffs of the contractors and the C. P. R. are provided in separate buildings. Several apartment houses and small dwellings are reserved for married men. There are stores at both camps, comfortable lounging rooms, post office and other institutions found in small towns. Emergency hospitals and surgeons are maintained at both villages and there is a regular police force.

Gangs of drillmen will be employed in three continuous shifts on the tunnel excavation work, which will be done from both ends at the same time. Work on the "pioneer bore" has been advanced at the eastern portal nearly a thousand feet into the base of the mountain, and a start has been made on the main bore from the east end. Operations will be commenced on


Entrance to "pioneer bore" Selkirk tunnel.

the preliminary shaft and the large tunnel at the western end at an early date. The excavations for the approaches at both sides are almost half completed.

The undertaking is being carried out for the C. P. R. by Messrs. Foley Bros., Welch & Stewart. Mr. A. C. Dennis is the superintendent in charge of the operations, while Mr. J. D. Shepperd, officially designated Assistant Engineer in charge of the Rogers Pass project, is the railway company's chief official representative on the ground. He makes his headquarters at the western camp, which is connected by telephone with the eastern camp and points along the line on both sides of the summit. Under Mr. Shepperd are two resident engineers, Mr. H. R. Phipps at the eastern end, and Mr. G. Macgilp at the west. The executive offices are at the western portal camp, and two entirely separate staffs are maintained by the C. P. R. and the contractors.

The camp at the entrance to Selkirk Tunnel.

Forms for Concrete Work

A PAPER on "Forms for Concrete Work" was read at a recent meeting of the Concrete Institute (London, Eng.), by Mr. Allan Graham. The author commenced by saying that we did not often hear of failures occurring in reinforced concrete buildings after their completion, but generally during their erection, and although all failures could not be attributed to defective forms, yet the forms were to blame in a sufficient number of cases to render the forms for concrete work an important element in securing efficiency in construction, and not merely in the utilitarian aspect. Although it was not the practice—in England, at any rate—for engineers to design their forms, that being generally left to the contractor, it was his belief, the author remarked, that an engineer, for his own protection, should at least set out some typical portion of the forms for the contractor's guidance, thus doing all he could to avoid failure in this direction at any rate. Of course, good forms alone would not ensure safety, and vigilance had likewise to be used in detecting bad work, bad design, and bad material.

Dealing then with terms used in concrete work, the author remarked that formwork was a term embracing all kinds of moulds or centering set up to give shape to the concrete or similar plastic material. It was so employed in America. There was a concensus of opinion in favour of the definition "formwork" as an inclusive term, owing to the real meaning of the term "centering" having a more limited application than was usually attributed to it. As the word "form" was the same, and had the same meaning in French, German, Italian, and Spanish, the author said he believed it would be agreed we were on safe ground if we accepted it for our purpose. The term had great merit, being superior to such terms as falsework or shuttering.

The contention that the engineer should prepare the design of formwork had much to recommend it. An engineer would generally have no hesitation in setting out the design of centering for a bridge or other equally important work, but for some reason or other the design of ordinary formwork which played such an important part in the cost of reinforced concrete was never considered. There was no doubt that a thorough understanding of the principles underlying the every-day practice of concrete form design was worthy of the best engineering talent. With this understood the problem could be analysed, the requirements realised, and the design decided upon that would be the most economical and efficient, due consideration being given to the salvage of materials.

It was not merely that a design for a specific case which would safely support a certain volume of concrete was required; it was rather the problem of designing a set of forms which could be erected, taken down, and many times re-used during the progress of work. The factors involved were many: such as the type of centering, the kind of timber, how much to centre at one time, and what clamps, bolts, nails, wire, or strap steel should be used. These things properly considered would repay the trouble taken and result in better and more economical work.

Various authorities placed the cost of formwork at anything from 20 per cent. to 60 per cent. of the total cost. The possibility of reducing this hindrance to the more general use of concrete ought to be sufficient inducement for us to give the matter close consideration. The great American constructional firms had struck out in many directions to reduce this cost to a minimum, and to this end the forms in most instances were designed in the drawing-office, at, we are told, a cost of 2 per cent. and a saving of 10 per cent.

The author then dealt with the kinds of timber that are used for formwork; the desirability of giving a camber to the bottom of beam boxes, and of carefully checking the measurements, to see that the concrete members were actually carried out as designed; the necessity of having joints close to prevent the mixture escaping; the remedying of cracks; the removal of forms; clamps and nails to hold the forms together; the repair and re-use of formwork; the number of sets required in order to get on fast enough with the work of building; the importance of carefully clearing forms of all sawdust, dirt, and chips before filling with concrete; the wetting of timber to prevent sticking; the use of sheet metal; the time for striking forms and methods of determining the strength. He then dealt in detail with forms for various parts of construction, as, for example, floors, beams and pillars, culverts, conduits, tall chimneys, silos, tanks, gasholder tanks, dams, domes, and bridges.

The following method for mixing the top layer of concrete floors has been successfully handled: Iron dust to the extent of 15 lbs. to 30 lbs. is mixed with 100 lbs. of the cement dry, and one part of this mixture to two parts of sand makes the slush for the top coat, which varies from one-half inch to one inch in thickness. It makes a hard and durable floor, thoroughly waterproof, and not slippery.

PROGRESS ON THE QUEBEC BRIDGE CONSTRUCTION

Substructure and Approach Spans Completed — Storage Yard and Contractor's Camp Established—Steel Received and Traveller Tower Erected

IMPORTANT progress has been made in the construction as well as in the design and fabrication of the $12,000,000 Quebec Bridge, and although the work is not yet imposing from the layman's standpoint, it has reached a stage and has included preliminaries that will permit rapid future progress. At the site the short approach spans and the difficult and costly superstructure for the main span have been completed, a camp established, contractor's yards laid out, plants installed and operations commenced in the storing of superstructure steel and the erection of traveller and falsework, thus providing for vigorous operation in the spring and for the erection of the main steelwork, which is now being fabricated and shipped to the site.

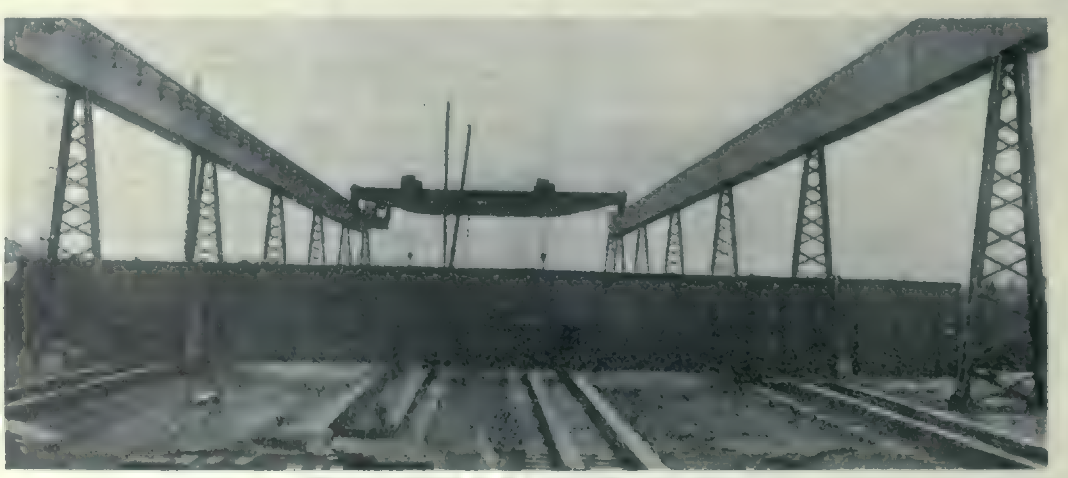
The two large main piers, located 1,800 ft. apart on the edges of the very deep-water channel, are of concrete construction with masonry facing and pneumatic-caisson foundations. The anchor piers, 2,830 ft. apart, are of similar construction, with foundations on solid rock above water level. They are a few feet eccentric from the old piers, so as to clear them instead of utilizing a portion of them, as was at one time intended. The old piers have been removed to low-water level, and part of the stone masonry contained in them has been used. The short approach spans at the north end of the bridge have been erected and standard-gage tracks on them connected with the railroad branch, so that material and equipment can be received and stored and the erection of the main spans can be undertaken as the falsework for the anchor arms is erected. The construction equipment is installed and the steel is at the site.

Erection will be commenced this spring at the north end of the bridge and at the south end next year, after which the work will progress simultaneously on both sides of the river until completion. At present the principal activities are on the north side of the river, but will be substantially duplicated on the south side in time to commence the erection there as soon as required by the programme of scheduled operations.

North Shore Plant

As the bridge site is in a rural district at considerable distance from towns large enough to provide convenient accommodations for the workmen, a construction camp has been established on the north shore to accommodate the erection force. Quarters have been provided for the engineers and other officers of the bridge commission and the contractors. The camp contains bunk houses with steam heat, electric lights and artesian water supply, besides which there are an office building, a commissary, kitchen, dining room, wash house, hospital, police station, repair shop and storage houses. Owing to the severity of the climate the working season for erection is limited to about six months, and the camp, which will be in service about four years, has been constructed with a view to durability and comfort for at least that length of time.

The power house is of fireproof construction and is equipped with four Ingersoll-Rand air compressors—



Storage yard with its 90-ton travelling girder crane.

one of which is intended to be kept in reserve—with a combined capacity of 2,000 cu. ft. of free air per minute. The compressing-current motors of 100 h.p. each, and two 250 kw. motor-generator sets are installed to reduce the 2,200-amp. current to 220 alternating current for the operation of the motors on the erection travellers. All of the principal installation is in duplicate and is proportioned so that there will always be a reserve.

The electric current is purchased by the contractor and is delivered on both sides of the river and connected by a cable across the channel so that either side may supply the other side. A duplicate plant will be established on the south shore of the river, thus providing for the eventual installation of four units, which, besides affording flexibility and reserve, were found to be cheaper than the installation of a single large plant with the required total capacity and excess.

The main travellers are each operated by mill-type General Electric motors. It is estimated that a total of about 500 h.p. on each side of the river will be required for all erection purposes when the work is in maximum progress, and that of this amount about 500 h.p. will be required to operate the air compressors which supply power for the pneumatic tools. Although a capacity of 800 h.p. is provided, it is expected that not more than 400 or 500 h.p. will be used at any one time.

Storage Yard

The storage yard is commanded by a two-trolley 90-ton girder crane of 81 ft. 3½-in. span, travelling on a runway 495 ft. long. The space commanded is crossed at one end by two standard-gage service tracks connecting with the bridge track and with the railroad branch. The remainder of the space between the runway girder is occupied by four full-length lines of double timber skids 4 ft. apart on centers, which have a capacity sufficient for the storage of all the steel required for either the anchor arm or the cantilever arm.

The girder crane and runway are substantially duplicates of those already installed in the storage yards of the fabrication shop in Montreal, and will eventually be removed there to supplement them. Excepting 33 ft. and 49½ ft. odd spans at the ends, the runway girders are 66 ft. long and are supported on battered steel columns 7 ft. wide transverse to the tracks at the base. Each column is made of four corner angles united by lattice angles and having the upper ends bent vertical and riveted between the inner faces of the double runway girders. The columns on one side of the runway are staggered with those on the opposite side so as to allow members longer than the width of runway to be moved to any position without turning.

Erection of one of the main travellers was commenced on shore at the north end of the bridge last fall and was completed to the top of the tower, a little beyond the point shown in the accompanying illustration, before work was suspended for the winter. The traveller, about 200 ft. high, has clearance between the trusses of the permanent structure and is of heavy riveted construction with a vertical tower of rectangular cross-section made with four vertical posts X-braced on all faces and horizontal bracing at each panel point.

The base of the tower is extended by trusses projecting from one side and is supported by four six-wheel trucks running on two 6½-ft. gage tracks. A pair of vertical trusses framed into the top of the tower cantilever 50 ft. front and rear, serve as runway girders for a pair of travelling cranes of 110 tons capacity with nickel-steel girders. These girders cantilever beyond both sides of the traveller so as to extend across the trusses and command them with their 55-ton trolley hoists.

The traveller weighs about 930 tons, or, with its full equipment, about 1000 tons. It will be provided with electric passenger elevator and hoisting apparatus. After erecting the falsework, the anchor arm and the cantilever arm on the north side of the river will be dismantled and reassembled at another site for the erection of the 640-ft. 5,000 ton center suspended span on shore falsework.

The fabrication of the 7,400 tons of steel in the floor system of the entire bridge and of the 1,400 tons of inside falsework and 470 tons of outside falsework for the north shore has been almost completed, and on February 1 about 8,000 tons of steel had been shipped to the site, besides 1,000 tons of floor system which had been completed and which are still stored at the fabricator's shops.

The work is under the direction of the board of engineers, of which C. N. Monsarrat is chairman and chief engineer. It is being executed by the St. Lawrence Bridge Company, of which Phelps Johnson is president and G. H. Duggan, chief engineer.

BRIDGE RIVETS OF UNUSUAL SIZE

Fabrication of the very large members of the new Quebec Bridge required the driving of numerous long carbon-steel rivets of large diameter, and unusual pains have been taken at the St. Lawrence Bridge Company's shop in their perfection and in the demonstration of the results obtained in driving them. Satisfactory results are reported to have been secured for the 1⅛-in. iron rivets in the pedestals under the main vertical posts. These rivets have a 9-in. grip and are 12 in. long before driving, thus requiring great efficiency in the machine and making it a difficult and costly matter to attempt cutting out and redriving, so that it is essential that they should be satisfactory at the outset.

The requirements are for the rivets to be driven at a cherry red. The cylindrical holes are drilled or reamed to a uniform diameter and the rivets are tapered about 1-32 in. in 12 in. from the end near the first head so as to completely fill the hole there when inserted. The points are chilled by being dipped in water before driving, thus tending to increase the upset in the middle of the shank, and the first heads are made long, affording a sufficient excess of metal to insure the formation of a 1-16 to 3-16 in. burr next the metal.

These rivets are driven as fast as those driven at a much higher temperature, and are not subjected to as much stretching by the springing of the riveted plates as when rivets are hotter. The driving has been so successful that practically no rivets have been condemned and cut out. Heating the rivets to a very high temperature for driving is objectionable on account of the scale that is formed and because the metal is then too soft to transmit the compression and produce a sufficient upset a long distance from the driven head.

The shop rivets are driven with pneumatic yoke machines and the field rivets will be driven with pneumatic guns and special pneumatic buckers-up having a pneumatic hammer contained in the plunger and operated during the first part of the driving. The plunger is controlled by a special valve, which first sets it up against the riveted member and maintains the pressure, after which the hammer may be simultaneously operated until the rivet is nearly driven from the opposite end, when this hammer is stopped and the static pressure continued until the driving is completed by the gun.

Specimen 1⅛-in. rivets 12 in. long were driven through several plates by the 80 and 100-ton yoke machines and by the pneumatic hammers. Afterward the plates were planed apart through the center line of rivets and those driven by the pneumatic hammers were found to be as good as those driven by the yoke machines and almost indistinguishable from them, all of the rivet holes being completely filled.

PRELIMINARIES TO ERECTING A GREAT BRIDGE

In this country where the shop fabrication of steel bridges is highly developed, where facility of erection is recognized as an important element of design and where extensive equipment is devoted to the erection of the superstructure, the field work on even very large spans is so rapid that it is generally measured by weeks or months and seldom, except for the very largest spans, involves very remarkable plant or is far removed from the commonplace. In notable contrast to this almost routine work is the erection of the Qeubec Bridge, the greatest span in the world. Over 60,000 tons of steel are to be assembled in three spans, of a combined length of 2,830 ft., 150 ft. above the water. The river is 200 ft. deep, with a tide of 15 ft. and a current of 8 miles. Pieces weighing 185 tons and compound members nearly 300 ft. long, weighing more than 1,200 tons, are to be handled in mid-air and assembled and maintained with precision. Two cantilever arms must be built out self-supporting for 580 ft. beyond their piers and remain exposed for months to the severest storms and a 640-ft. double track 5,000 ton railroad span must be built at a distance, floated to the site, raised 150 ft. and connected to them with great speed and accuracy.

It is expected that all this can be accomplished in four years of elapsed time, or less than half as much working time, since work must be discontinued during the long and severe winters. To do this, elaborate provision is now being made for all the construction operations, the schedule is prepared for the successive steps and the details of operations are being minutely worked out, instructions prepared and machinery, tools, supplies and every needed facility provided in advance, due regard being had for the utilization of certain parts of the equipment repeatedly to avoid unnecessary duplication. Even with this care the cost of installation of the whole erection equipment will considerably exceed $500,000, exclusive of maintenance, supplies and labor, so that the total erection expense reaches thousands of dollars a day for the actual working time.

The structural steel in the falsework, travellers and yard equipment for temporary work will be about 4,000 tons; two 800 h.p. electric power plants and two sets of air compressors will be required; two 1,000-ton steel tower-travellers, 200 ft. high, must be erected and equipped, and a massive steel falsework, more than equivalent to permament railroad viaducts, must be built not only for the temporary support of the permanent trusses, but also for the separate support of the great travellers. Barges and falsework must be built for the 640-ft. span, and special hydraulic apparatus provided for lifting it to place. Provision must also be made for the maintenance of a large force of men at the site.—Engineering Record.

THE civic investigation, now closed, into the cause of the break of Montreal's water conduit was characterized by a remarkable divergence of opinion between experts. Broadly speaking, the experts were divided into two camps, one attributing the accident to the poor design of the conduit, and the other to the excavation of earth in the widening of the aqueduct, thus undermining the conduit. Messrs. Jamieson, Lea and Heckle, the engineers who reported on the break for the city, gave evidence to the effect that the conduit failed to stand the conditions for which it had been designed; the concrete was good, but the metal reinforcement was not strong enough. It was admitted, however, that the excavation of the earth was a contributing cause to the break. Opposed to the views of the above experts, which was supported by the evidence of others, were the opinions of Col. H. R. Lordly, chief engineer of the Lachine Canal, Mr. G. Janin, and others. Their evidences went to show that the break was due to the excavation on the aqueduct side, making an unbalanced load. The use of the drag line excavator was also criticised, it being further declared that the design of the conduit was good. Mr. M. J. Butler, president of the Canadian Society of Civil Engineers, and head of the Armstrong Whitworth Company of Canada, expressed the opinion that the excavation could have been done safely by building a retaining wall in short sections, as the excavation proceeded. The wall should have been built especially opposite to such places where the conduit was too close.

Grading has been started on the last section of the Canadian Northern Pacific Railway on the mainland of British Columbia. According to a statement made a few days ago by Mr. S. H. Sykes, assistant chief engineer, the entire line will probably be ready for the rails next july. About sixty per cent. of the grading has been done on the twenty-mile section west of Albredo Summit, and track laying will be commenced from the present end of steel ten miles west of the Yellow Head Pass, early next month. Between the present completed sections of the line several bridges are now under construction.

The salary of Mr. Alfred Craven, Chief Engineer of the Public Service Commission, First District, New York City, has been raised from $15,000 to $20,000 per annum, making his salary the highest of any engineer in the service of New York City or the State. In the capacity of chief engineer of the commission Mr. Craven has charge of all the work of the dual subway and transit system now under construction, involving the expenditure of $167,000,000.

A deputation of about two thousand from Western Ontario waited upon the Premier and the Cabinet at Ottawa a few days ago to urge upon the Government the necessity of proceeding immediately with the deepening of the St. Lawrence River, to make an ocean waterway. The deputation also urged that the projected 6,400 miles of Hydro Radial lines in Ontario should receive the same government subsidy that other railways on the continent received.

A Self-Anchored Suspension Bridge at Cologne Embodying Interesting Features*

A NEW highway bridge presenting many interesting features is in course of erection over the Rhine at Cologne. The bridge is what may be termed a self-anchored suspension bridge and was designed by the Maschininenfabrik Augsburg-Nurnberg A.G. The suspension chains, instead of being led to land anchorages as usual, are anchored by bolts to the stiffening girder itself and put it under compression. The stiffening girder is continuous over four supports, so that the system as a whole is three times statically indeterminate. This will be the first bridge of large dimensions built in Europe (and perhaps in the world) of this type. The designers, prior to entering upon their calculations, made experiments upon a model bridge with a view to satisfying themselves as to how the stiffening girder would fail under compression. Under test loads the stiffening girder was found to cripple between panel-points, and the calculations for crippling were made upon this basis.

The entire width of the deck, including one roadway and two footways, is between the stiffening girders, so as to provide clear, uninterrupted passage from side to side, giving pedestrian traffic the facility of crossing over at will from one footway to the other. As the stiffening girders project above the deck, this transverse communication would not be possible with footways cantilevered out.

Every consideration has been given in the design to providing an unobstructed deck and free outlook upon the river, two points of paramount importance from the point of view of the public. The stiffening girders are made to serve as bulwarks or railings; their top angles are at the uniform height of 36 in. above the footways for the whole length of the bridge.

The fixed bearing of the stiffening girders is on the west pier; the other three bearings (east pier and both abutments) are movable longitudinally.

In contrast to an ordinary suspension bridge with land anchorages, the deformation of this structure due to loading has no appreciable effect upon the internal stresses—that is, the internal stresses are the same whether the calculations are based upon the original system diagram or upon the deformed one. Further, under a temperature change that is uniform in the whole bridge no additional stresses are induced, as the geometric figure of the structure always remains similar.

Main Dimensions

The main dimensions of the bridge are as follows:—mid-span, 605 ft.; side spans, 302.5 ft. each; width between stiffening truss, centre to centre, 62.6 ft. The approaches are of reinforced concrete construction and are slightly wider (66.7 ft.) between the railings.

This will be the first large bridge to be built in Europe in which nickel steel is to be employed. The approximate weights of the different metals are:—nickel steel, 6,500 tons; carbon steel, 2,200 tons; cast steel, 220 tons.

The permissive working stresses are:—

(a) Mild Steel	lbs. per sq. in.
(1) Road and footway construction	11,400
(Under steam-roller loading) ..	14,200
(2) Windbracing	14,200
(3) Rivet shear. For road and footways	9,200
For main girders and windbracing	12,800
(4) Rivet bearing: Twice the shear values.	
(b) Nickel Steel	
(1) Floorbeams	17,000
(Under steam-roller loading) ..	23,400
(2) Suspension chains, vertical load only	25,000
Vertical load, wind and temperature	30,700
(3) Stiffening girder	23,400

Stiffening girders.—Each stiffening girder has one fixed bearing on the 12th panel point (Fig. 1), the other three bearings being movable, and is arched upwards to improve its appearance. It is of inverted U section with a top flange-plate, the bottom being open to facilitate inspection and repainting. For a comparatively short length (for the first three panels) the top flange plates are discontinued so as to allow the suspension chain to be brought in between the webs. At the ends of the stiffening girders the suspension chains are anchored by bolts 2 ft. in diameter. The web plates of the stiffening girder are from 126 in. to 216 in. deep, splices being necessitated on the centre line. Rigid internal diagrams are provided at frequent intervals, and the whole girder has been carefully proportioned to withstand the buckling tendency of the 4,000-ton load induced by the suspension chains.

Suspension chains and hangers.—The chains are formed of nickel steel links connected together at the panel points by 12-in. bolts, except near the ends where larger bolts are used because the links are fewer and wider. The links are not of the usual American eye-bar type, but are formed as plates with parallel edges, a hole being bored near each end to take the pin and reinforcing plates being provided to strengthen the eyes. A bearing pressure of 45,000 lbs. per sq. in. and a tensile strength of 23,700 lbs. per sq. in. at the weakest section are allowed. The chain has a parabolic curve with a dip in the middle span of 60.5 ft. (one-tenth of the span) and 75.8 ft. in the side spans. The number of bars forming the complete links of each chain vary from six to twelve, their thicknesses varying from ⅞ in. to 1 in. Towards the ends the number of links decreases, but the width increases to keep the area constant, the maximum width being 59 in.

The hangers are 5½ in. in diameter, each having a turn-buckle in the centre for adjustment of length during erection; they are connected to the chains and to the stiffening girders by pins of 5½ in. diameter. It was the original intention of the designers to form every third hanger as a built-up riveted member, in order to break the monotonous appearance of a long line of round bars and to make in a distant view a more prominent connection between the chains and the stiffening girders; the authorities, however, were

---

*By E. S. Andrews in the Engineering Review.

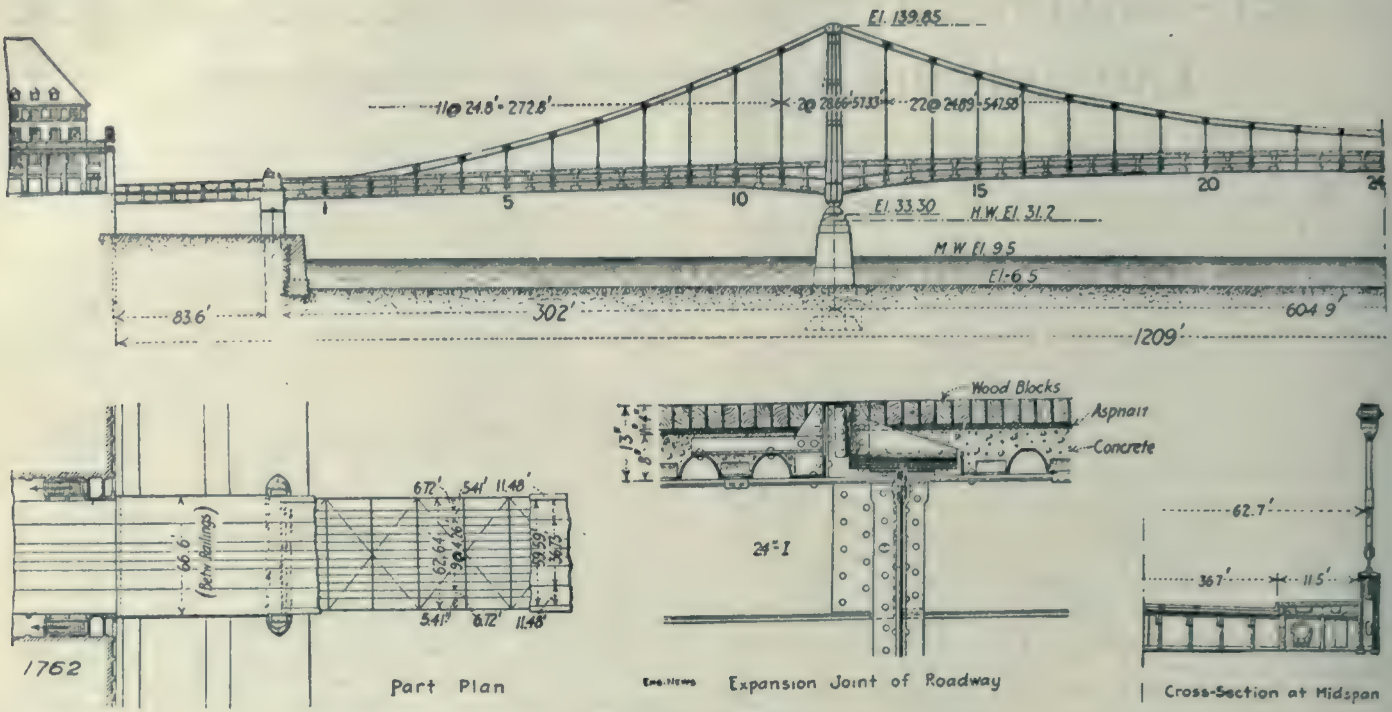


Fig. 1—Cologne Bridge.

opposed to the suggestion. To give lateral support against wind pressure to the suspension chain at the centre, a rigid member is used in place of a pivoted hanger.

Towers.—The general form of the tower is fairly clearly indicated in Fig. 2; the posts are liberally stiffened with internal diaphragms, and have manholes to facilitate inspection and painting. The maximum load per tower is 3,600 tons, and, in addition, there are to be carried bending moments due to wind pressure. The stiffening girder passes through a slot in the base of the tower post and rests upon a roller-bearing inside the tower.

Bearings.—The bearings at the abutments are not only movable, but are arranged to take up either downward pressure or uplift. The bottom roller, 12 in. takes the positive loads. Uplift is taken up by three rockers on top, acting against a shoe which is held down by four anchorage bars. The maximum uplift per girder is 440 tons; each anchorage bar is proportioned for 110 tons pull.

The bearings of the stiffening girders at the towers are built up of top and bottom castings machined to spherical shape. The contact surface has a diameter of 28 in. The top saddle casting is securely bolted to the tower post. Fig. 2 shows this bearing.

Windbracing.—The windbracing is located under the floorbeams. The distribution of wind load is as follows: wind pressure on the hangers distributes equally between suspension chain and stiffening girder. Wind loads on the roadway are taken up by the lateral system. Wind pressure against the chain is transferred at five points, tower tops, abutments, and rigid hanger frame at mid-span.

Roadway.—The roadway is of wooden blocks on a concrete base, while the footway is of asphalt on concrete. In every fourth panel the roadway is divided by an expansion joint, so as to be less affected by the

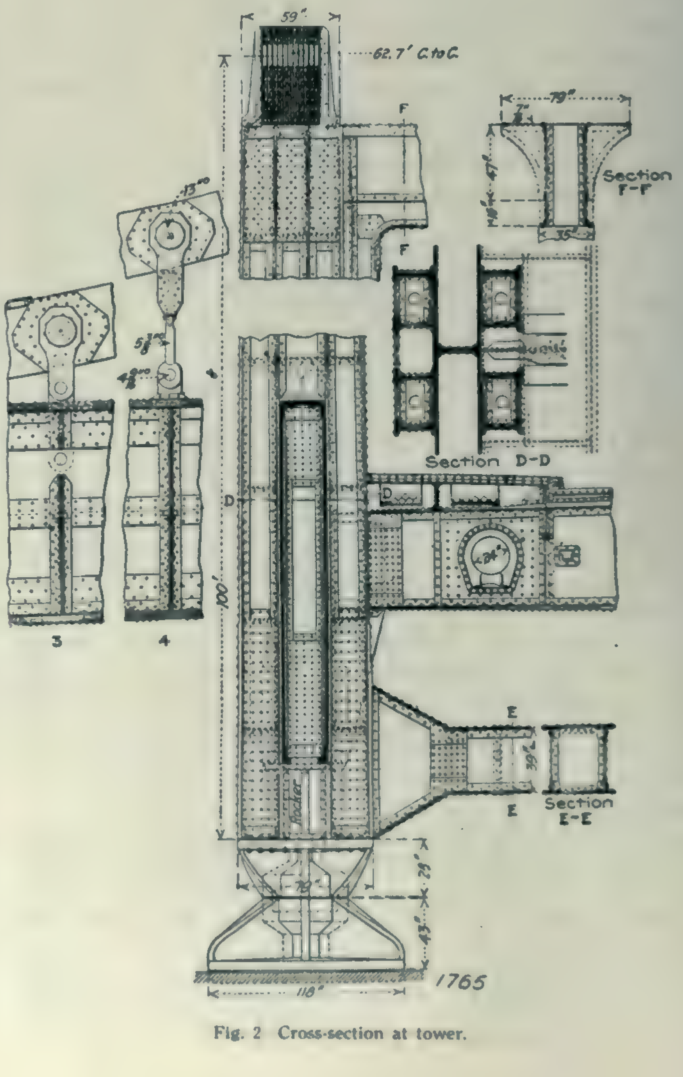


Fig. 2 Cross-section at tower.

elastic deformation of the main system. The drainage water is carried by longitudinal gutters to the bridge supports and there discharged by downpipes.

An inspection wagon running on the bottom flanges of the stiffening girder is provided for inspection and repair purposes.

As the bridge has no land anchorages, the pull in the suspension chain cannot be taken up until the stiffening girder is erected and ready to be put under compression. The erection of the stiffening girders and the chains will therefore proceed simultaneously on special staging, and it will be so conducted that the stiffening girder is completed first.

Though the completed bridge is statically indeterminate in the third degree, it will be erected as a determinate structure; to this effect three hinges will be built into the stiffening girder; at the towers and at mid-span. Besides insuring absence of undesired initial stresses, this also simplifies the calculation of the erection stresses and deflections. When the stiffening girder is finished and the suspension chain connected thereto, every third hanger will be coupled up. The staging carrying the chains will then be removed and the remaining hangers coupled up and adjusted by means of the turnbuckles to bring the pin points into their correct positions, after which the splices in the webs and flanges of the stiffening girder at the three hinge-points will be riveted up.

Operation of Small Rapid Sand Filters

Determining Proper Quantities of Coagulants and Hypochlorite for Varying Conditions of Turbidity, Color and Alkalinity

By H. P. Setton*

IN connection with the operation of small rapid sand filters, the writer has felt for some time the need of a discussion of the whole problem from the viewpoint of the man in direct charge of the operation. As he pointed out in a paper recently presented before the New England Water Works Association, small water purification plants are often poorly designed and more often poorly operated. The operator is not, as a rule, responsible for the design and while in the matter of operation he often makes mistakes, they are in the majority of cases due, not to carelessness or neglect, but to ignorance or lack of training.

A rapid sand filter cannot be operated by any set rule, day in and day out, for the reason that the character of the water to be treated does not remain constant. Moreover any set of rules which might work successfully in one location would perhaps prove an absolute failure in another.

With the above facts in mind, an attempt will be made in the following discussion to outline the best methods of operation as shown by the writer's experience. The processes will be taken up in regular sequence, beginning with chemicals and coagulation, and each step will be discussed thoroughly before going to the next.

The matter presented is designed to be particularly useful to the small plant having no laboratory control, as this is the type most generally mismanaged. It is believed, however, that those in charge of larger plants may find something of profit in the comparison of their methods with those given here.

Chemical Treatment

Coagulation and Coagulating Chemicals.—The question of proper coagulation and sedimentation, which is of prime importance in the operation of rapid sand filters, is often the least understood of all the steps in the process and therefore receives less attention than it should.

In order to effect efficient removal by the filter of either bacteria, turbidity or color, it is essential that a good precipitate be formed which will settle and drag down with it a large per cent. of all the above substances and yet leave enough flock in the water entering the filters to form a suitable slime layer on the surface of the sand.

By far the greater number of small plants use sulphate of alumina as the coagulent, and this discussion will therefore be confined to that chemical.

In order that coagulation or precipitation may take place it is necessary that the raw water contain sufficient alkalinity to combine with the sulphate of alumina and form the flocculent aluminum hydrate. By alkalinity is meant the temporary hardness of the water. It is usually expressed in parts per million of calcium carbonate. Many waters contain at all times alkalinity much in excess of that needed to effect coagulation, while others vary greatly at different times. In most streams the alkalinity is the lowest at times of greatest flow with its resultant high turbidity. For this reason alkalinity tests should be part of the regular routine operation. The test is not a difficult one, requires but a small amount of apparatus, and with a little practice can be carried out by the filter attendant. The apparatus and solutions needed and the method of making the test as prescribed by the "Standard Methods of Water Analyses" of the American Public Health Association are given below. (The book just mentioned should be in the hands of every man in charge of the operation of a rapid sand filter plant.)

The apparatus needed for the alkalinity test is as follows: One glass stoppered bottle holding about 250 cubic centimeters, one burette for titrating, one 5 cubic centimeter pipette, one 2½ cubic centimeter pipette, one 100 cubic centimeter graduate. The technique of making the test is as follows: 100 c.c. of the water to be tested is placed in the bottle; to this is added 2½ c.c. of erythrosine solution (0.1 gram of the sodium salt is one liter of water), and 5 c.c. of chloroform (neutral to erythrosine). The mixture should now be well shaken and, if the pink color persists, fiftieth normal (N/50) sulphuric acid should be added from the burette, a little at a time, shaking thoroughly each time until the pink color disappears. Each 0.1 cubic centimeter of sulphuric acid used is equivalent to one part per million of alkalinity expressed in terms of calcium carbonate.

---

*Of the U.S. Public Health Service.

One grain of sulphate of alumina per gallon will theoretically reduce the alkalinity about 8 parts per million. When treating waters with high turbidity, however, it is often found that this theoretical amount is much reduced, probably because the turbidity absorbs a certain amount of the chemical before coagulation takes place. In conditions such as this it will be found advisable to add a small amount of chemical and then, after a period of sedimentation, to add another small amount.

It is essential that the water be alkaline after treatment, as otherwise free alum will be found in the water. Free alum is detrimental to health, besides rendering the water extremely corrosive and also preventing its use in some industrial processes, such as dyeing. It sometimes happens, when large amounts of chemical are added to a very turbid water, that the alkalinity is not all used up, but the water nevertheless contains free alum. At such times, or whenever the presence of free alum is suspected, the following simple test will be found convenient: Fill a test tube half full of filtered water. Add four or five drops of Haematoxylin solution (1.0 ounce Haematoxylin to 8.0 ounces of water), or sufficient to give a bright red color, and then add one drop of dilute acetic acid. If the water is free from alum, the color on the addition of the Haematoxylin will be bright red, which on the addition of the acetic acid will turn to a straw yellow. If there is alum present, the color on the addition of the Haematoxylin will vary from a greenish brown to a bluish black, which will not change on the addition of the acetic acid. This test will show free alum in the proportion of one part in five million.

In order that the filtered water shall always be alkaline, it is not advisable to add more sulphate of alumina than will reduce the alkalinity three-fourths. If this amount of chemical is insufficient for proper coagulation, it will be necessary to artificially increase the alkalinity. This is generally effected by adding to the raw water a solution of soda ash or crude sodium carbonate. One grain per gallon of this chemical is equivalent to about two grains per gallon of sulphate of alumina.

There are numerous brands and grades of these two chemicals on the market at varying prices, but it is believed to be economy to buy a good quality, especially of sulphate of alumina. The following specifications call for a chemical of high grade. These specifications, or very similar ones, are used in buying the chemical by almost all of the larger plants and should be adopted by the small ones also. It would be well to buy in large quantities and have the shipment tested to determine whether the specifications are being followed. The specifications are:

The basic sulphate of alumina shall be guaranteed to contain 17.5 per cent. of alumina (Al_2O_3), soluble in water, and of this amount at least 5 per cent. shall be in excess of the amount theoretically necessary to combine with the sulphuric acid present. It shall not contain more than 0.5 per cent. of iron (Fe_2O_3), and the iron shall be preferably in the ferrous state. The alum shall be crushed to pieces of such a size that they will pass through a ring three inches in diameter.

Solution Tanks.—The solution tanks, whether of wooden or concrete construction, should be provided in duplicate. The best method of dissolving the chemicals is to have in the top of the tank a V-shaped trough, either of wood or concrete, of a sufficient size to hold the necessary amount of chemical for a tankful of solution. Above and parallel with this trough should be a water pipe, perforated with numerous small holes, one row pointing directly downwards and a row pointing towards each side of the trough. By this method it is possible to so regulate the flow of water over the chemical that it will all be dissolved by the time the tank is full. If some such method is not used with the soda ash and instead it is dumped into a tank of water, it will crystallize and form a very hard, almost insoluble, mass in the bottom of the tank.

After the chemicals are entirely dissolved, the solution should be thoroughly agitated for a few minutes in order to make it uniform throughout. This can be done in small tanks, either by simply stirring with a stick or by a hand-operated paddle arrangement. A convenient method in those plants using compressed air for washing the filters is to have in the bottom of the tanks a series of perforated brass pipes through which air can be blown, thus thoroughly mixing the solution. Piping for handling the alum solution should be preferably lead or brass, as iron pipe is quickly corroded. Whatever kind of pipe is used, there should be inserted numerous unions and plugged tees and crosses to facilitate cleaning. If convenient, there should be a connection to a water pipe, as this makes possible the thorough flushing of the chemical lines whenever needed. Iron pipes are satisfactory for the soda ash solution.

Calcium Hypochlorite.—While treatment of the water with calcium hypochlorite is really not a part of the filtration process, its use in connection with rapid sand filters has become so general that the methods of handling it will be discussed at this point.

The chemical when fresh is a dry powder containing about 35 per cent. available chlorine. It is generally furnished in steel drums holding either about 350 or 700 pounds. After standing open for some time, the chemical takes up considerable water, and the per cent. of available chlorine decreases. For small parts it will be found economical to pay slightly more for the chemical and have it packed in smaller containers, say holding 100 pounds. The percentage of available chlorine in the powder should also be determined, as otherwise doses much less than intended are liable to be added. The test is not a difficult one, and if the reagents are made up by a chemist the plant attendant can carry out the determination. The preparation of the solutions and the methods of testing are described quite fully on page 72 of Water Supply Paper No. 315 of the United States Geological Survey, entitled "The Purification of Public Water Supplies." This pamphlet, which can be obtained without cost, will prove of value to all interested in the subject. Whether the powder is tested or not, the solution actually fed to the water should be, as this is the only way to know the actual rate of application.

Tanks for hypochlorite solutions should be made of concrete or iron. Concrete is the best, as it is not attacked by the solution. Wooden tanks are quickly destroyed by the action of the chemical, but if only wooden tanks are available they may be made satisfactory by being lined with a layer of cement mortar plastered over a layer of chicken wire netting or metal lathing which is nailed to the sides of the tank.

Lead piping should preferably be used for carrying the solution, but whatever pipe is used the same precautions against stoppages mentioned under alum tanks should be adopted.

The chemical is soluble in about twenty times its weight of water, but it is not advisable to use it in more than a 2 per cent. solution. For the plant treating elss than a million gallons per day it will be better to use a one or a one-half per cent. solution, as it is extremely difficult to regulate the small flow necessary with the stronger solution.

The solution tanks should be provided in duplicate, and each should be capable of holding enough solution to run about twelve hours. The following table will be found convenient in determining the size of solution tanks needed and the rate of feeding the solution:

Parts per million available chlorine	0.2	0.4	0.6	0.8	1.0
Pounds of hypochlorite per million gallons	5	10	15	20	25
Gallons of water to make a one per cent. solution ...	60	120	180	240	300
Gallons of one per cent solution to be fed per hour per million gallons per day	2.5	5.0	7.5	10.0	12.5

Suppose it is desired to treat 550,000 gallons of water per day at the rate of 0.4 part per million available chlorine using a one-half per cent. solution. From the table, opposite the required amount of chlorine, it is seen that 10 pounds of chemical and 120 gallons of water are required for a million gallons using a one per cent. solution. With a one-half per cent. solution 240 gallons of water would be required. Since it is wanted to treat 550,000 gallons, there would be required for one day 0.55 of 240 gallons, or 132 gallons of water, and 0.55 of 10 pounds, or 5.5 pounds of chemical. This would need to be fed at the rate of 5.5 gallons per hour, or a pint every minute and 22 seconds.

For the small plant the best method of making the solution is to mix up a paste of the chemical, using at least a half gallon of water for each pound of hypochlorite. This paste can then be put in the solution tank and diluted to the required quantity. The most important point to be observed is to get all the available chlorine dissolved. This requires that the solution be agitated for some time after mixing. If the mixing is thorough, there will be little active chlorine left in the sludge which settles in the bottom of the tank. It is advisable to have the draw-off pipe opening about four inches above the bottom of the tank, as in this way the clear solution can be drawn off without disturbing the sludge. This sludge should be flushed out at intervals to prevent its getting into the solution pipes and causing trouble by clogging the regulating orifice.

Amount of Chemicals to Be Added.—The necessary amount of sulphate of alumina to be added to a water depends on several different things. If a clear colorless water is being treated for the removal of bacteria, only enough chemical is needed to form a flock which will deposit on the filter and prevent the passage of the bacteria. As a general rule, 0.5 grain per gallon will suffice for this purpose. When a water is turbid, the amount needed will depend on the amount of turbidity. In a properly operated plant the turbidity is measured at least once a day, and the chemical dose regulated from this measurement. For turbidities under 100 the most simple arrangement for reading the turbidity is to have a series of standard clay turbidities prepared in pint bottles, a good series being turbidities of 10, 20, 30, 40, 50, 75 and 100. The standards should be prepared in accordance with the Standard Methods of Water Analyses mentioned heretofore. The writer is quite certain that, in those states where the state board of health has a laboratory, it would be more than willing to prepare standards of this kind without charge, unless for the materials, which would be very little. When the writer was in the employ of the New Jersey State Board of Health he had standards of this kind prepared and furnished to all the plants of the state that did not have a laboratory in connection therewith. In return, the daily records of turbidity and chemical added were reported once a month. Where the turbidity is over 100, the above standards can be used by diluting the water to be tested with clear water and taking account of this fact in figuring the turbidity. Unless this is done, a candle turbidimeter, as used by the U. S. Geological Survey, will be required. At one plant in New Jersey the man in charge made his own standards by filling bottles with the actual raw water at times of different turbidity. He found by experience the necessary amount of chemical for each turbidity and thereafter regulated the dose according to these standards. This is a satisfactory method, but its objection is that the results cannot be compared with other plants.

The following table from the American Civil Engineers' Pocket Book, page 928, will be found valuable in approximating the necessary amount of chemical.

Since conditions vary so much, it is probable that these quantities will not give just the right reaction in every case. For this reason a similar table should be prepared at every plant in accordance with actual conditions found. After this is done the chemical dose can be regulated from the turbidity readings.

What has been said with regard to turbidity applies equally well to those plants whose chief aim is to remove color. The color of water does not, as a rule, fluctuate as rapidly or as much as turbidity, but it is much harder to remove. Color standards similar to those described for turbidity are in use at several New Jersey plants. The removal of color generally requires more chemical than for turbidity and longer periods of coagulation. Unfortunately waters highly colored with organic matter are usually very low in alkalinity, many times even being of acid reaction due to humic acid from the swampy areas in which the water rise. A color of 10 can just be noticed in a glass of water on a white cloth, while a color of 25 or over is very striking. It is absolutely essential that a plant handling a water of this type be regulated in accordance with alkalinity and color determinations. Without such regulation there is great danger of having free alum in the filtered water; while if soda ash and alum are added in such uniform quantities as to never have this happen, the plant is not being economically operated. Besides this, larger doses of sulphate of alumina make the water corrosive, causing the unpleasant "red water" troubles in house piping. Because of this fact and because it is good business, the chemical dose should be kept as low as is consistent with proper color removal. This is only possible with careful operation based on the tests mentioned above.

In plants handling waters almost always turbid or colored, if sufficient chemical is used to effectively remove the turbidity or color, the bacteria removal will generally take care of itself. In other words, more chemical is needed to remove turbidity and color than to remove bacteria. In fact, a water slightly turbid is much easier to treat than a clear water, as the settling of the turbidity drags down with it the greater parts of the bacteria. This action has been taken advantage of at a few plants by adding to the clear water entering the coagulation basin a mixture of clay and water, thus causing an artificial turbidity. This is particularly ap-

Average Amounts of Sulphate of Alumina Necessary to Use for Different Turbidities and Color

	Alum		
Turbidity	Grains per gallon	Pounds per million gallons	Alkalinity necessary for reaction. Parts per million
0	0.50	72	5
50	1.00	143	9
100	1.35	193	12
200	1.78	254	16
300	2.05	293	18
500	2.50	357	22
700	2.87	413	25
1,000	3.32	474	30
1,500	3.39	557	34
2,000	4.40	628	38
Color.			
50	1.00	143	9
100	2.00	286	17
200	4.00	572	35

plicable in starting coagulation in a clear colored water.

The amount of hypochlorite necessary to properly disinfect the water will depend primarily on the amount of pollution therein. A clear ground or filtered water, but slightly polluted, will require only about 0.2 part of available chlorine per million. Most surface waters will require about twice this amount. A water that is very turbid may require as high as 1.0 part per million to effect good bacteria reduction. There is always danger of tastes and odors in a water treated with hypochlorite, and while these qualities are not detrimental to health they are very unpleasant. A water high in organic matter will often give tastes which are not due to the chemical itself but to its effect on the organic matter.

There is only one way to properly control the amount of hypochlorite needed, and this is by bacteriological tests. Where a laboratory for making these tests is not available, however, the test proposed by G. Sims Woodhead will be found a valuable aid. This test is as follows: Fill a quart bottle of clear white glass with the treated water and add to it a small crystal of potassium iodide, a few drops of weak acetic acid and a teaspoonful of starch solution. Shake well and hold bottle over a white paper. A blue tint indicates too much chlorine while a violet tint shows the correct amount. The starch solution is prepared by weighing out a small quantity of starch, mixing it to a paste with a little cold water and then adding this paste to two hundred times its weight of boiling water and allowing to boil a couple of minutes. A few drops of chloroform added to the bottle in which the solution is kept will preserve it. The writer knows of one plant treating about 30,000,000 gallons of water per day that uses the above test almost exclusively in determining the necessary amount of hypochlorite.

Place of Adding Chemicals.—There is more or less difference of opinion among authorities as to the best places to add the various chemicals. It has been the writer's experience that where soda ash is used it should be added before the sulphate of alumina a sufficient time to allow perfect mixing to take place. The two chemicals should never be added through the same pipe or at the same place, as is sometimes done at plants where the action of the chemicals is not understood. In a plant treating water with high turbidities, where the coagulation basin is so arranged that it can be divided, it will often be found advisable to divide the dose of sulphate of alumina, adding part of it where the water enters the second division after some of the turbidity has settled. The total amount of chemical needed will generally be lowered if the above plan is followed. Another method of operation which will sometimes reduce the amount of chemical needed can be used where the coagulation basin is large enough, this scheme being to overdose the water for a time with sulphate of alumina and then not add any for a while. It has been found to be very efficient and economical at Springfield, Mass., in connection with slow sand filters.

In a rapid sand filter there are three places where calcium hypochlorite can be added. These are in the raw water, the coagulated and settled water, and the filtered water. When added to the raw water, a large amount of chemical is required, but its regulation does not need to be overly accurate. It is undoubtedly less effective here than at the other two points, as in a well regulated plant the coagulation basins remove a considerable percentage of the bacteria without hypochlorite. When added to the settled water, less chemical is required, and its regulation does not need to be especially accurate, since the filters will remove most of the tastes and odors. Another advantage is that the load on the filters is lessened by adding at this point. In the writer's opinion, under most circumstances the best place to add the hypochlorite is to the filtered water. Much less chemical is required at this point than at the others, but the regulation must be more accurate in order to avoid underdosing, or overdosing with its resultant tastes and odors. The main advantage lies in the fact that the disinfecting action at this point is a factor of safety for all the previous operations.

Wherever the chemical be added, it is necessary that a period of contact be allowed for the disinfecting action to take place. This period varies with the character of the water. A clear, only slightly polluted, water requires only a small amount of chemical and a period of about an hour. A heavily polluted water requires a large amount of chemical and a contact period of only a few minutes.

Steel is not only displacing timber in railway carriage construction, but also in goods vehicles of various classes. In order to obtain rigidity and strength it is usual to ridge or corrugate the plates in various ways, but according to the Railway News a new method of construction is finding favour in some quarters, and particulars are available of a goods wagon in which the entire end is formed of a single sheet of steel pressed with concentric annular corrugations, no posts, braces, or rivets being required. The plate is attached to the car body by means of bolts or rivets engaging the corner angles, and it is claimed that the design releases additional space inside, adding about a foot to the length available.

The National Paving Brick Manufacturers' Association recently had an exhibit of paving. A slab of brick pavement taken from the streets of Columbus, Ohio, was shown, to prove vitrified block's permanency. This pavement had been laid nineteen years and the brick showed practically no wear whatever, despite heavy traffic conditions.

Small Sewage-Pumping Plants*

By S. A. Greeley and Langdon Pearse†

THE design and operation of small sewage-pumping stations is a subject upon which very little has been written. One reason, perhaps, is that the use of such stations is avoided as far as possible in the design of sewerage systems for the smaller towns and villages, even at the risk of flattening grades to a point where thorough scouring may not always occur at low flows. However, on small areas and frequently on large areas where conditions are imperative, pumping stations are built to lift the sewage into the outfall sewers or to works for treatment.

In the design of the small stations, there are several points to be considered. (1) Preparatory treatment by screens is required to protect the pumps. This is more important on small installations, particularly those where attendance is intermittent. Bar screens with net openings of ½ to ¾ in. are common. There should be ample provision for ready cleaning and accessibility. (2) There should be provision of storage in a suitable well or tank, in order that pumps of reasonable size may be used with intermittent pumping. Sometimes pumping installations may serve to dose treatment works. The design should provide bottom slopes steep enough to keep the sludge moving to the pumps. (3) There is the question of location and character of buildings. (4) The total cost for operating and maintenance capitalized and added to the construction cost will give a means for comparing the relative merits of different sources of power available.

For the small sewage-pumping station, where intermittent attendance is planned, the use of electrically-driven pumps would seem to be ideal. They are clean, self-contained, noiseless, and easily controlled by well developed devices for automatic starting and stopping. Attendance is thereby reduced to a minimum. The equipment is usually compact and may be installed in comparatively small space. The cost of pumping depends on the local energy rates and is clouded only by the necessity of pumping intermittently rather than continuously. This increases the peak load on pumps.

Electrically-driven direct-connected pumps operate efficiently and economically. The recognized features would seem to be (1) vertical motors with a suitable oil bearing to support the moving parts of the motor; (2) support of the moving shaft and runner of the pump on a ball or roller bearing (placed above high water), and (3) connection with the motor by a flexible coupling. Steady bearings are desirable on the shaft at frequent intervals, with provision for oiling and accessibility. It is highly desirable, with any type of sewage-pump installation that it be set in a dry well (so far as possible) so that none of the moving parts requiring lubrication will be exposed to the sewage. This may frequently contain grit, which is destructive to bearings. The necessity of keeping gritty water out of water seals and bearings has not always been recognized by designers, as operating men have found.

Gas engines have also been developed for this service, operating on natural gas or artificial gas from mains. But with a very few exceptions (notably a small pumping station in Newton, Mass., handling sewage of about 760 people, with two 3½-in. centri-

---

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors.

†Division Engineers, Sanitary District of Chicago, Chicago, Ill.

TABLE OF COST DATA AND STATISTICS OF SEWAGE PUMPING

		Approximate water hp.		Cost of construction per w.hp. capacity	Cost of operation per w.hp. output per yr.				
Station	Type	capacity	output		Labor	Fuel	Repairs, supplies, etc.	Total	Date of data
1. Pennypack Creek, Phila	Producer gas	45.0	9.0	$450	$735	....	....	....	1913
2. Hegewisch, Chicago	City gas	30.5	21.0	465	1890	$210	$323	$2423	1912
3. Alewife Brook, Boston	Steam	50.0	7.7	....	828	210	95	1133	1912
4. Quincy, Mass.	Steam	70.0	15.2	....	417	110	48	575	1912
5. Saratoga, N.Y.	Electric	31.8	....	170	....	....	....	....	1907
6. Hudson, Mass.	Electric	8.0	....	450	....	....	....	....	1907
7. Newton, Mass.	Electric	2.5	0.14	840	775	1020	1105	2900	1906
8. Plainfield, N.J.									
Monroe Ave.	Air	....	0.25	....	....	760	....	....	1912
Randolph Road	Air	4.5	1.00	1040	....	586	....	....	1912

Note:—A water horsepower is figured from the rated capacity or actual output of water per day and the total life.

(1) Pennypack Creek Sewage Disposal Works, Philadelphia, Penn. Present average quantity pumped, 1,000,000 gal. per 24 hours, against 50-ft. head. The equipment consists of one 2,000,000-gal. and one 3,000,000-gal. vertical submerged centrifugal pump, geared to gas engines; and one 150-h.p. gas producer operated with anthracite coal.

(2) Hegewisch Sewage Pumping Station, Chicago, Ill.—Built in 1909. Present average quantity pumped, 1,500,000 gal. per 24 hours, against 10-ft. head. Two 10,000,000-gal. centrifugal pumps, and two 40-h.p. gas engines using city illuminating gas.

(3) Alewife Brook Pumping Station, Metropolitan Sewerage Works, Boston, Mass. Present average quantity pumped, 3,500,000 gal. per 24 hours, against 13-ft. lift. Two 4,500,000-gal. vertical centrifugal pumps, and one 13,000,000-gal. horizontal centrifugal pump; all operated by compound steam engines.

(4) Quincy Sewage Pumping Station, Metropolitan Sewage Works, Boston, Mass. Present average quantity pumped, 4,000,000 gal. per 24 hours against 22-ft. lift. Three centrifugal pumps of 3,000,000, 5,000,000 and 10,000,000 gal. capacity, operated by compound condensing engines.

(5) Saratoga Springs, N.Y. Daily pumpage varies from 1,500,000 to 3,000,000 gal. per 24 hours against 30-ft. lift. Three vertical submerged centrifugal pumps with capacities of 1,500 gal. per min. each, and three 20-h.p. induction motors.

(6) Hudson, Mass. Two vertical centrifugal pumps, each with a capacity of 500 gal. per min. against a total head of 35 ft. Each pump is operated by a 15-h.p. induction motor.

(7) Newton, Mass. The average daily quantity pumped in 1906 was 25,565 gal. against 30-ft. lift. Two 3½-in vertical submerged centrifugal pumps geared to 5-h.p. vertical gasoline engines.

(8) Plainfield, N.J. Randolph Road Pumping Station. Present average quantity pumped, 130,000 gal. per 24 hours against 40-ft. lift. Two 10 x 6-in. compressors; two 7.5 h.p. electric motors, one gasoline engine for reserve, one 3½ x 8 ft. air receiver, and two duplex displacement ejectors. The plant capacity is approximately 500 gal. per min.

Monroe Ave. Pumping Station. Present average quantity pumped, approximately 30,000, gal. per 24 hours against 40-ft. lift. Two air compressors, two 5-h.p. electric motors, and two 150-gal. ejectors. The plant capacity is approximately 300 gal. per min.

fugal pumps), the developments have been mostly in the larger stations, such as the East Side plant at Columbus, Ohio, where two 60-h.p. gas engines operate two 10-in. centrifugal pumps, chain-belt driven. At Hegewisch, in Chicago, the pumps are run by gas engines fed from the city mains. The latter installation is belt-driven and pumps the entire sewage, as well as a large proportion of the storm flow. The Columbus station handles only the dry-weather flow and a very small proportion of the storm sewage. The Newton station is semi-automatic, being started two or three times a day by a fireman from the neighboring waterworks pumping station. A stopping device is installed.

The use of producer gas for the purpose of sewage pumping, as well as waterworks pumping, appears attractive, but has not been used to any great extent for small installations, since the attention of the promoters of producer gas has been directed largely to industrial installations, and the municipal field has been left untouched. There is, however, a station operating at Pennypack Creek in Philadelphia.

Gasoline and kerosene for sewage pumping are, of course, available, but with the present price of gasoline, the cost is high. Kerosene is less expensive, but seldom used. However, engines working on distillate, common in California, should prove as successful for sewage pumping as they have for irrigation. Madison (Wis.) pumps all the dry-weather flow with engines converted to run on kerosene.

Sewage installations, however, require to be operated intermittently, as a rule, and therefore need automatic control where attendants are lacking. This favors the direct-connected, compact, electrical units. The gas engine and other types of explosion engine require somewhat more attention and care in order to secure successful operation. For the sewage-pumping station in the small town, steam-driven machinery is generally out of the question, as the efficiency here is low and the cost of attendance high. It is only when the installations are operated in connection with other works that steam appears to be attractive for small stations, working on low lifts and handling amounts of sewage under 1,000,000 gal. per day.

Some interesting data on the cost of small plants are given in the accompanying table, showing the cost calculated to water horse-power, regardless of the efficiency produced. We have also tabulated the costs of operation as taken from the various records in print. These costs of operation are given with the reservation that if used they should be carefully studied from the standpoint of actual application to a case in hand, as there is a tendency in many municipal records as given out to make as good a showing as possible by giving only the charges apparently chargeable to the pumping account and carrying other incidentals where necessary in other ways. Notes giving various particulars of the sewage pumping plants listed in the table are appended to the table.

A Practical Discussion of Waterproofing Problems

By Louis G. Mauer

THE problem that interests most of us is how to obtain most satisfactory results in waterproofing at a minimum cost. There are two classes of waterproofing—one underground, the other above. Underground work, as a rule, is subjected to water pressure either by seepages, springs or direct pressure where basements are below tide or streams. Work of this character requires an entirely different method of treatment than waterproofing the building above ground, since it must effectually resist a constant water pressure. Walls above ground are not subjected to constant water pressure, therefore they require a treatment to be water repellant: that is to say, a remedy to prevent the absorption of water.

Enumeration of Methods

There are four distinct methods employed to accomplish waterproofing results:

First. By density of the materials from which your walls are constructed; density of the material itself or the aggregates of which it is composed.

Second. By the membrane system. This method is used principally for underground work. For floors it is placed between concrete slabs, or on the outside of walls where the water pressure is against the wall.

Third. By a surface coating composed of asphaltum, tar, or any oil base material. The latter being water repellant, fairly good results are obtained. A surface coating is only efficient, however, as long as the material applied remains intact.

Fourth. By non-absorption or the elimination of capillary attraction. The material I have found to accomplish this result is a chemical solution having a water base, and which can be readily mixed in the cement aggregates for either underground work or surface application above ground.

In regard to the first method—Density—you are probably all aware that the aggregates of a concrete mass or cement mixture may be proportioned in such a manner as to obtain a density that will not permit the perculation of water, but to obtain this result in a concrete wall or plaster surface after they have hardened would incur a task that would not be practical for ordinary construction, nor could this method be judiciously applied to a brick wall which is always more or less porous and absorptive.

The Membrane System

The second method, the membrane system, is one that is very successfully used. To adopt this method for floor work it is necessary to place a concrete slab, then the membrane system, composed of asphaltum and felt, in such number of layers as deemed necessary, then the additional slab of concrete. The upper slab necessarily must be of sufficient strength to withstand the hydrostatic pressure. The actual cost of this method is the felt and asphaltum membrane, plus the cost of the lower slab of concrete. The membrane being composed of an absolute foreign material to the concrete does not become a component part of either slab or concrete—in fact, separates them entirely, the only bond between the two slabs being the cohesion of the asphalt itself.

Although it is claimed that the membrane system of waterproofing is to a certain extent elastic, still, it is frequently found that breaks occur when the concrete slabs develop contraction cracks, thereby impairing the results of waterproofing efficiency.

The membrane system is also used on the exterior of walls. This requires the necessary excavation to give room for applying the membrane. The cost of this work is the membrane plus the cost of excavation and back-filling of same, and in many cases a protection wall. If for any reason a membrane system could not be applied on the outside, and same would be adopted on inside of wall, it would be necessary to construct a special wall; otherwise, if the water should percolate through the outer walls, it would press away the membrane. The cost of this work for inside walls would be the cost of membrane plus the cost of wall to hold the membrane in place.

If, for any reason, breaks should occur in the membrane system, permitting water to penetrate the membrane, it would not necessarily mean that the break is where it shows on the surface, as the water may travel some distance between the membrane and the upper layer of concrete before finding the weakest point to the surface.

Surface Coating

The third method—surface coating—is used quite extensively for treating walls above ground, and to a certain extent for underground work as well.

By applying a good surface coating of asphaltum, tar or any oil-base material where the water pressure presses the coating against the wall, good results will be obtained so long as the life of the asphaltum or oil is retained in the coating. As a rule the oils are quickly absorbed when applied to any absorptive surface, leaving the solids of the coating as a more or less inert substance with its binder, in fact, its principal element of life, separated. To avoid this it is very important to have a foundation that will prevent the separation of oils and solids contained in the surface coating.

To apply a surface coating on the inside of walls under plastering, the so-termed damp-proofing or plaster-bond coat is, in my opinion, an absolute waste of the expense incurred. This applies to all material without exception. Whenever a wall is thoroughly saturated with water from the outside up to the point of the damp-proofing coat, there is no material, be it ever so elastic, solid or efficient, that will withstand the pressure. As a matter of fact it must then withstand a direct water pressure instead of being only a water repellant at intermittent intervals.

The fourth method—non-absorption—means the elimination of capillary attraction. Under this method and by using the materials referred to I have accomplished results on those problems that have come under my direct supervision, both underground where subjected to severe water pressure, and in treating buildings above ground by surface application. This material is a chemical solution (water base contains no oils), penetrates an absorbent substance and becomes a part thereof, accomplishing the waterproof results, not by the filling of voids or a surface coating, but by making the substance to which applied non-absorptive and impervious to water.

If you will carefully analyze the fact, you will find that even a very porous material containing a large percentage of voids will not become saturated with water unless it is absorptive, nor will you find that water will follow fine cracks in any surface, unless the substance itself has suction and absorb water. Now, then, this being a fact, the method of waterproofing by having the aggregate of the material made non-absorptive to resist water pressure and eliminate capillary attraction, for all surfaces exposed to water absorption at intermittent intervals, is one that will solve many of your difficulties.

Underground Work

Let us first consider its application for work below ground. In basements we accomplish results by the most direct and simple means. The plastering of the walls on the inside with waterproof mortar and the floors with waterproofed mortar topping, thereby saving the expense of exterior excavation and cribbing which would be necessary in order to apply a membrane or surface coating to the outside is good practice.

On new work where walls are green and bonding of plaster certain, no greater expense is involved than the nominal cost of the waterproofing material, which is to be added to the sand and cement for plastering and topping.

But in old basements or any surface not permitting a perfect bond, quite a different problem presents itself. Here the surface to be plastered must be carefully prepared to insure proper bonding of plaster by roughening the surface. We all know the weakest point is the angle between the floor and wall, therefore particular care must be taken to reinforce this point by forming a cove so as to make the connection between the floor topping and wall plaster continuous.

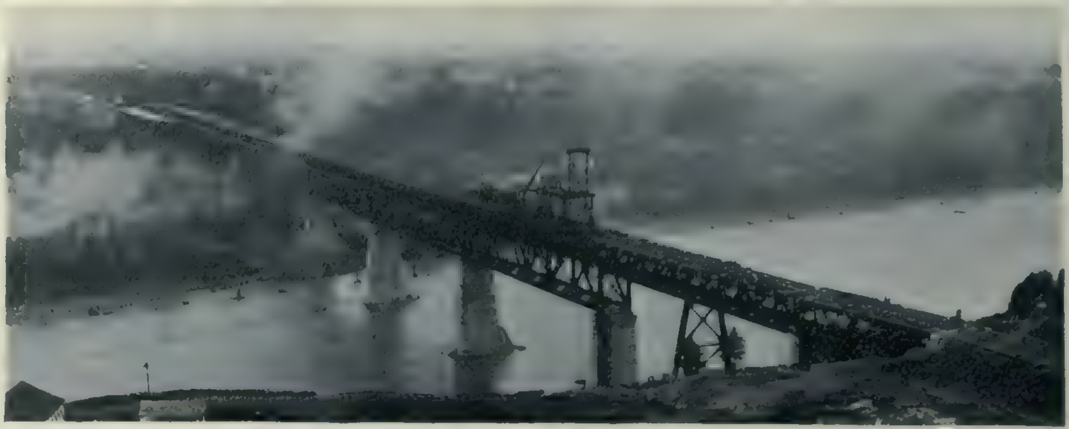
Should the argument be advanced that floors or walls waterproofed are liable to crack, thereby causing leaks, let me say that the chances are very slight indeed, if the walls are properly designed and constructed and the floors thick enough to resist the hydrostatic pressure.

Walls and floors that crack due to contraction or expansion or other causes will sever or open up a membrane almost as quickly as a plaster coating. And what is the result? A heavy expense is incurred, owing to the fact that the break in the membrane may be many feet away from the point where the leakage shows on the surface. With the membrane method repairs are virtually impossible, while a waterproof plaster coating may be quickly and permanently repaired at very small expense. The leakage always exists where it shows on the surface. The cracks could easily be cut out to a certain depth and pointed up, making same absolutely water tight.

Many basements presenting all sorts of conditions from seepage of ground water to tide pressure have been successfully waterproofed with this method. I would not hesitate to undertake to make absolutely dry any basement under the most severe water pressure by plastering it on the inside and using this material as a part of the water gauging the cement and sand mortar. This mortar can be applied even while the water is percolating through the wall.

If necessary the mortar could be held in place with boards pressed against the wall. This might develop small holes, permitting the water to escape, but which could easily be plugged up after the other portions are thoroughly set. Cement mortar applied on walls saturated with water will gradually dry out even with the water pressure against the wall.

No doubt this question will come to your mind: will the use of this material, used in the aggregates of



C.P.R. high level bridge, Edmonton, Alta.

cement mortars, be detrimental to its strength or cause additional labor in its use? In answer to this, I wish to state that on the contrary the use of this material is a decided advantage; the initial set is somewhat retarded, but in thirty-six or forty hours you will find the cement mortar much harder and stronger, this in comparison with equally proportioned cement mortar gauged with water alone. The working of cement mortar is also made much easier and smoother, the action being similar to that obtained by the use of lime putty in cement mortar.

Surface Application Above Ground

For treating a building above ground, the result can be obtained by a thorough surface application, by either brush or spray, preferably the latter. By this I mean every particle of the wall must be saturated. This will leave no surface coating and will not change the color or texture of any surface to which applied, be it a white sand or a lime stone or a red brick. A surface application will only give results and become effective when applied on any absorptive material.

Take, for instance, a porous brick. It requires very little effort to obtain penetration with this material of ¼ in. or even ½ in., and to this depth waterproof results would be found, permitting you to remove a part of the surface and texture of the brick, without destroying the waterproofing efficiency.

The method employed for treating walls that require a change of color is this: Waterproof as above mentioned, then apply any concrete paint for color effect only. By treating the walls with this material you have the most perfect foundation for any oil base material. The surface made non-absorptive prevents the absorption of the oils in your paint pigments. This, as you all know, is the life of any oil paint.

At this time I wish to caution you to guard against careless workmanship by the individual mechanic, the economical use of the material contrary to directions and requirements, and the lack of knowledge of these special problems by those in charge of the work.

Many big buildings in Berlin are built entirely of brick, and sandstone is used for outside walls and trimmings. In the Reichstag building in Berlin 32,000,000 brick were used, while in the new Dome church also in Berlin, over 25,000,000 brick were used. Other large brick buildings are the Anhalt depot and the City Hall.

The C.P.R. High Level Bridge at Edmonton

DURING the past year the Canadian Pacific Railway completed the erection of the bridge across the North Saskatchewan River to give them entrance into the city of Edmonton. The structure has a total length of 1761 feet and is 125 feet above the high water level of the river. On the upper deck are two street railway tracks and the track of the C. P. R. Calgary Branch, and on the lower deck is a 23-foot roadway with 8-foot sidewalks on either side. The south end of the bridge is a viaduct, with nine towers. The north end has one tower with two plate girder spans. The central portion is five deck trusses of varying spans. The main spans are three deck Pratt trusses, two with spans of 291 ft. 10½ ins., and one with a span of 293 ft. 3 ins., and all are 48 feet deep. The two shore spans are deck Pratt trusses with 130-foot span, 19 feet deep. The viaduct at the south end consists of six bents of 96-foot deck trusses and 48-foot towers, the trusses being 18 feet deep, and two bents of 60-foot deck girders with 30-foot towers. The main channel piers are 140 feet high and 25 feet wide. The bridge allows the railway entrance into the city proper. A part of the line in the city required a 20-foot cut, with street cross-overs. At two points there have been erected reinforced concrete bridges to carry streets over the cut. These bridges are of the beam and girder type, with small columns, and cantilevered sidewalks. On the south side of the river there has been erected a reinforced concrete retaining wall tunnel, carrying two intersecting streets. The tunnel is 206 feet long, with a retaining wall 35 feet high, and has a 24-inch solid slab from wall to wall to carry the streets. The two walls are 18 feet, face to face, and are in alignment with the six degree curve at this point. The design of the high-level bridge was made in the office of the C. P. R. Bridge Engineer, at Montreal.

More than twenty concrete piers built several years ago, and submerged in the United States Navy Yard at Boston, are again being examined to note the action, both mechanical, due to frost, and chemical, due to ingredients in the sea water. As this subject is one which has a large bearing on the permanence of piers, abutments, sea walls, etc., when built of concrete, these experimental tests are expected to yield some very valuable results.

Materials and Methods in Producing Satisfactory Road Carpets

By Major W. W. Crosby*

BEFORE the advent of the motor vehicle the maintenance of water-bound macadam roads was easily and satisfactorily accomplished by simple methods at a cost of from $50 to $250 per annum, and when properly maintained such roads were easily constructed, agreeable to their users and abutters, and advantageous from every point of view. Then, as motors began running over these roads, an early notice given of their effect was the rise and offensive distribution of dust. Comment expressed the idea that the road metal was fast being removed from the road, and distributed in finely divided condition over the adjoining property. Shortly afterward the loosening of the road metal appeared, and, when sufficiently loosened to so permit, it was found frequently to have been piled in windows along the sides or edges of the road crust, leaving pot-holes or ruts in its former location.

The necessity for preventives against the dust, the loosening of the road metal and its dislodgement was quickly apparent, and experimentation began. Water sprinkled on the dust temporarily prevented its distribution, but its effects were not lasting, and, aside from the expense and inconvenience of sprinkling as often as found to be necessary for satisfactory results, certain disagreeable concomitants seemed unavoidable. Excess in application was an apparent necessity, and the resulting mud was in many cases seriously objectionable. The effort was then made to reduce the mud nuisance to a minimum, and at the same time to prolong the effects of sprinkling, by the addition of hygroscopic salts, such as calcium chloride, to the water. In many cases improvement resulted, but it was found that with motor traffic beyond a certain amount, even this treatment did not prevent the loosening and dislodgement of the road metal.

At the same period, oily liquids were tried in place of water, probably with the idea that they would so weight and otherwise affect the dust as to prevent its distribution, and at the same time be longer in evaporating from the road. In some cases the results of oiling were disastrous. The dust, it is true, was prevented from forming clouds and being blown about by every passing breeze, but in place of this there was formed on the road a greasy mixture which was thrown up on to goods by horses or the wheels, or tracked by the feet of persons into dwellings. It spotted everything it touched, and it seemed in many cases that "the last state" of that road "was worse than the first." Further, it soon appeared that where motor travel was at all heavy this oiling had not been effective against pot-holing or rutting.

In other cases the oiling had been attended with most satisfactory results. The dust was suppressed, the road metal prevented from loosening, and the pot-holing and rutting consequently avoided. It even seemed that the road surface had really been improved in some ways. It was smoother (perhaps, in a few cases, injuriously so under certain weather conditions), less noisy, less glaring in unshaded spots on bright days, and more resilient, apparently, to horses' feet. But further, and what to many appeared to be the most important result, it seemed that, coincidentally with the other good results, the wear on the metal forming the road crust had been reduced materially or even obliterated by the formation over it of a carpet composed of the adhesive portions of the oil (or tar) and the sand, stone chips, or fine material such as the dust, found or spread on the road surface. This carpet took the wear and thus protected the road metal. As long as the carpet remained intact no surface wear of the stones composing the macadam was possible, and little or no dust was formed from the carpet itself that could not be absorbed or held by it for a considerable period. Further, the presence of an appreciable carpet prevented the loosening of the stones of the road crust if it did not actually increase their bond, and thus the resistance to pot-holing and rutting was increased materially.

The advantages of a proper carpet were readily apparent, and a way out for the localities in the peculiar situation first referred to was opened. Previous to its discovery they had faced the prospect of being obliged to meet great increases in their annual expenditures for maintenance with the almost certain knowledge that when the motor travel should have increased beyond a certain figure there would be nothing left for them to do but to reconstruct their roads, probably with paving at a high cost, or they had to face such immediate reconstruction if the increase in maintenance charges seemed sufficiently imminent and formidable.

Limits of Carpeting System

With the possibilities held out by "carpeting" the roads came, of course, the questions of what the limits of such treatment were then, of the possibility of their extension, of the proper methods and materials for success within such limits, the causes of failures or dissatisfaction where such had occurred in practice with carpets, etc., etc.

It was soon proved that there were limits to the successful adoption of carpeting methods for the improvement of macadam roads, or for adapting the latter to withstand otherwise destructive travel. If, as the name implies, a "carpet" is an appreciable thickness of cementitious material mixed with a mineral or other aggregate, it naturally follows that there may be travel conditions just too severe for support without damage by ordinary macadam and yet not severe enough to warrant the construction of a "carpet" on the surface of the latter. In such cases the simple treatment occasionally—say, annually—of the macadam with a proper oil, tar or pitch compound has proved entirely satisfactory and economical. In such cases no appreciable thickness of carpet is formed on the macadam, and the stones of the latter still continue to take the wear though they do not then loosen and become displaced as they would without the pitch application. Of course, in these cases a carpet could be used, but until the amount of travel justifies its use, it often would be unnecessary and not economical under the local conditions.

On the other hand, if we differentiate between a mixture of pitch and grit made "in situ" and a, perhaps, similar mixture made previous to placing on the road surface and then spread and rolled into place, by referring to the latter as a "sheet pavement" and limiting the application of carpets to roads carrying heavy travel. For instance, if the travel comprises a very large number of hard-tired vehicles carrying extremely heavy loads, it has been found that a carpet will not prove economical though a sheet pavement may. The trouble seems to be that the particles composing the carpet are not of sufficient mass to resist disintegration under such stresses, nor to be able to resist lateral displacement before or after fracture under such loads, or that the proportions of the different sizes of particles forming the aggregate are not right.

---

* State Engineer to the Maryland Highway Commission.

Again, it is found that if the proportion of horse-drawn to motor vehicles is too large, a carpet is in danger of destruction from being perforated or picked to pieces by the caulks of the horses' shoes. Perforations allow water to penetrate and to weaken the bond to the macadam, and continual picking at the carpet by the caulks breaks it to pieces unless the rolling and compressing action of motor and other wheels is sufficient to off-set both.

The determination of the exact limits, in terms of travel units, to the successful use of carpets is not yet established. It is affected by climatic and other local conditions, by the character of the pitch employed, by economic factors, etc., and because of the importance of the economic factors and the comparative newness of the problem, even the approximate determination must be deferred for the present.

The possibilities of extending these limits when once approximately determined will naturally be clearer then; and such possibilities may be increased, of course, by the improvement of materials and methods now being developed.

Materials and Methods

The question of the proper materials and methods to be used in order that successful carpets may be had within reasonable limits for such work are many and varied, and in so many cases the decision is so largely affected by local considerations that generalization is difficult. However, it may be said that the writer's experience with many hundred year-miles of this work leads him to state as follows:

(1) A 12-ft., water-bound, limestone macadam will not successfully support travel aggregating 400 units per average day of ten hours, and where 60 per cent. of the total travel is that of motors.

(2) Such a road surface can be made to sustain such travel with physical satisfaction by a carpet made with proper pitch.

(3) An 18-ft. water-bound, trap-rock macadam is incapable of sustaining, without serious deterioration in a few months, travel aggregating 2,500 units per average day of ten hours, and where 90 per cent. of the total travel is that of motors.

(4) The surface treatment of such a road surface with a proper cut-back asphalt or a proper compound of tar will enable it to sustain such travel with physical satisfaction.

(5) The use of sand on top of the pitch is open to grave objections, and the value of its use before spreading the pitch is questionable, clean stone chips of small gravel, free from particles that will not pass a ⅛-in. mesh, being preferable.

(6) With the use of a proper pitch, no material advantage is had by closing the finished carpet to travel for a period after its construction, provided the adhesion of tires to the surface is prevented by watering, spreading an excess of grit, or other means.

(7) The construction of a carpet on a macadam adds immaterially to the supporting power of such macadam, except as it may increase its ability to protect the foundation by shedding water.

(8) The successful thickness of a carpet is that but slightly in excess of the height of the larger sized particles of the grit used, and the maximum successful thickness is not over 1 in., but generally nearer ½ in.

(9) Better results are secured from applications of the pitch hot and under pressure than from cold gravity applications.

(10) Where the quantity of pitch to be applied is to exceed one-third of a gallon per square yard, better results will be obtained by making two or more applications of it.

(11) For pitch carpets, a pitch compound, to be satisfactory, should show at least the following characteristics:—

(a) It should flow freely, though not excessively so, under the conditions of applications.

(b) It should show, after evaporation at 105 deg. Cent. for twenty-one hours (20 grammes in 3½-in. dish) a percentage of residue neither above nor below certain limits, dependent upon local conditions, and this residue should show a penetration of not less than 10 at 4 deg. Cent., nor more than 200 at 25 deg. Cent. (No. 2 needle, 100 grammes 5 sec.)

(c) The naphtha soluble portions of the residue above mentioned should, when evaporated on glass, show themselves to be decidedly adhesive.

(d) The amount of "free carbon" present in tar compounds should be less than a maximum percentage of the fraction distilling between 225 deg. and 300 deg. Cent., the figure for this maximum being dependent upon local conditions.

(12) The best grit for carpets is clean stone chips or pea gravel, free from more than 20 per cent. of fine materials, that will pass a ⅛-in. screen.

(13) For the sake of uniformity in spreading, the mechanical application of the grit is preferable to manual application, even at the expense of some waste of material.

Failures frequently teach more than successes. And under their consideration may perhaps be most impressively discussed their causes.

(14) A poor foundation frequently explains the failure of any pavement or road crust. The best carpet can do no more to remedy a poor foundation than by aiding to prevent water reaching the latter.

(15) Complaints of excessive slipperiness on carpeted roads are often heard, and these are most frequent perhaps where old macadam roads have been so treated. With the smoother surface of the carpet, less crown than ordinarily supplied on a macadam is necessary or desirable for drainage purposes. But as the carpets were applied to these old roads, in many cases without the reshaping of the macadam, the completed work has excessive crown. This is conducive to sideslip—the thing objected to. Where the cross-section is planned for the presence of a carpet and the proper crown so provided, carpeted roads are not objectionably slippery unless a pitch is used which becomes too hard at low temperatures. (See 11b).

(16) A carpet will not prove satisfactory that varies greatly from a uniform thickness or composition. If potholes and ruts exist in the old road it is useless to attempt to remedy them by simply carpeting the

surface. The necessary repairs must first be made and its carpet applied, the results being directly proportionate to the surface condition of the road carpeted.

(17) A carpet must have appreciable thickness, and, within limits, the greater the travel the thicker the carpet needed. Successful carpets, even with light travel, can seldom be made with less than ¼ gallon pitch per square yard.

(18) A pitch compound which does not "set up" or harden rapidly and sufficiently to a certain degree (see 11b), will not produce a satisfactory carpet, nor will a pitch that is too greasy in character. The former will be objectionable, as were certain oil treatments referred to, and the greasy pitch will produce a carpet that will shift about under traffic, add to the effort required for hauling over it, and probably emulsify in wet weather into intensely disagreeable mud. A layer of this mud on the surface of even a good macadam road frequently seems to be the cause of the whole road "going to pieces," or of its "bottom dropping out" during an open winter.

(19) "Cut-back" pitches, far from being objectionable when properly compounded, are frequently most desirable for carpeting work, but their composition should be most carefully limited. Many failures have been due to the use of compounds improperly made by the addition of the wrong light fractions to poor or even good, hard pitches.

(20) One of the most frequent causes of failure of carpets comes from lack of proper adhesiveness on the part of pitch compound. A greasy pitch compound is seldom sufficiently adhesive, nor is one which fails to pass the setting-up test. Unless the adhesion of the carpet to the base is good, the carpet will be worn loose, and then easily destroyed, as the body by itself is light.

(21) The cohesiveness of the carpet body depends, of course, largely on the adhesiveness of the pitch compound. But the adhesion may be practically destroyed (and the cohesion of the carpet body also) by the use of the pitch compound on a dirty or dusty surface, or with materials containing too great a proportion of fine material. The presence of moisture may with some pitch compounds also produce a similar effect. Ordinarily, however, the presence of a moderate amount of moisture has not nearly so bad an effect as the presence of a small amount of fine stone dust ("flour"), or similar material. Indeed, with some materials drenching the road surface with water previous to applying the pitch compound is reported to be advantageous. Many failures in carpeting have been traceable to the use of the old worn-out dust from the road surface in place of suitable clean, fresh grit.

(22) Some apparent failures with carpets have been so classified simply because of impatience on the part of those in charge of the work. It frequently happens that a first attempt does not produce the result desired or anticipated, and a failure is recorded when a second attempt would have produced entire satisfaction. New carpets sometimes seem to scale or flake badly from the old road surface. Prompt patching, followed (where a properly light application was first made) by a second coat, frequently results in a most satisfactory surface.

The successful use of carpets for the protection or improvement of macadam roads has been so great that its development for other situations has followed. The noisiness of brick pavements, and even of stone block pavements, and many of the inherent defects of concrete as a pavement, have often been reduced or cured by the use of a proper carpet, and the satisfaction with, or advisability of, each of the surfaces mentioned thus greatly increased, to say nothing of any economy in the use of the carpet by the resulting prolongation of life in the more expensive pavement. From the experience of the writer, he believes that, especially in cases where considerable well-built water-bound macadam exists, but now needs protection from motor traffic, the system of carpeting such roads or streets is most worthy of deep consideration, and that those authorities such as the British Road Board, who apparently have carefully and earnestly applied themselves to this subject, have acted wisely.

Economic Design of Standpipes and Conduits

The economic design of standpipes and conduits for water-supply purposes was presented mathematically by H. E. Babbitt (instructor in Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.) at the annual convention of the Illinois Water Supply Association. For standpipes a total of sixteen factors were considered, including not only the dimensions of the pipe, the thickness and weight of the steel plates, the foundation, costs of materials, labor, etc., but also the cost of pumping water 1 ft. high, and the capital charges on the extra initial cost of the pipe to decrease the pumping cost. Assuming that the standpipe is to be used for storage between pumping and that it is to be filled and emptied once each day, "the most inexpensive standpipe which can be constructed, whether of 1,000 gal. or 1,000,000 gal. capacity, should have a height of 23 ft., if the cost of pumping is not considered," and 15 ft. if it is considered. Changes in the values of one of the 16 factors may materially change the economic height. Thus, if steel be taken at 2c. per lb. instead of 5c. the height should be 36 ft. instead of 23 ft., if pumping costs are ignored, or 17 ft. instead of 15 ft. if pumping is considered.

The studies for the economic design of conduits were based on the following assumption:

> In the design of a large gravity water conduit of any considerable length, passing through various classes of material, and with a limited total loss of head, it is less expensive to allow a relatively steep grade to the more costly portion and a relatively flat grade to the less costly portions, than if the entire conduit were laid at the same grade with the same sections through all classes of materials. It is thus evident that there is some relation between the grades for each section which will give the minimum cost for the entire conduit.

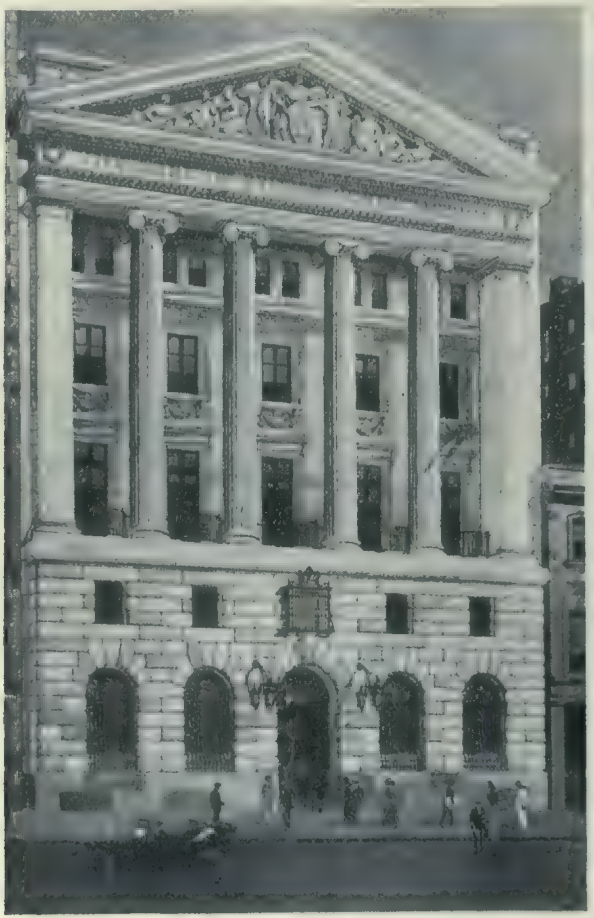
Examples are worked out for different classes of materials, slopes and diameters. In the discussion reference is made to the proposition of Wiggin advanced in "The Catskill Water Supply of New York, by Lazarus White," as proving graphically that "if a series of parallel tangents be drawn to the cost curves such that the sum of the ordinates of the points of tangency is equal to the total permissible head, the least cost of the entire conduit will be obtained by constructing each section of conduit with the loss of head indicated."

A steel bridge 1¼ miles in length and consisting mainly of forty 150-ft. spans has just been completed by the Bengal Northwestern Railway Company across the Jumna River at Allahābad, India.

The B. B. N. A., Montreal

Within the past three or four years, Montreal has added several very fine banking offices in the business district, particularly in St. James Street. The Bank of British North America is the latest institution to rebuild, and Norcross Bros., Montreal, have just completed a magnificent structure on St. James Street, from designs by Barott, Blackader and Webster, Montreal.

The building has a frontage of 70 ft. 7 ins., with a depth of 100 feet, and a height of 90 feet to the top of the pediment. There is a sub-basement, basement, and five floors. The exterior is constructed of Stanstead granite, a feature being the number of columns also built of granite. The walls are of terra cotta.



The Bank of British North America's new building at Montreal.

The sub-basement is devoted to the book vaults and the boiler room; while the basement contains the safety deposits and the security vaults, with provision for housing the dynamos. The ground floor is the principal room; here are situated the banking offices, the public space being 40 x 34 feet. The height of the room is 29 feet; the ceiling is 29 feet high, and is decorated in blue and gold. The manager's room, writing room, and committee room are built on the front portion of the ground floor and are reached immediately from the vestibule. At the rear of the tellers' and other banking spaces is the clerks' working department.

Above the ground floor is the mezzanine floor, containing the inspectors' rooms; on the first floor is the general manager's department; while on the fourth floor there is accommodation for the clerical staff, kitchen, dining room, and three bedrooms. The first floor and general manager's offices are furnished in mahogany and the other portions of the building in oak. A large amount of wrought iron is used, notably the lamps over the main entrance in St. James Street. The grilles in the banking department on the first floor are of bronze.

There are two elevators, one for public use on the left-hand side of the main floor and the other for service at the rear of the working department on the same level. The lighting is by electricity. The cost is about $500,000.

Mechanical Filtration

A paper on the above subject was read at a recent meeting of the Manchester Association of Engineers (Eng.). The author devoted the major portion of his paper to a description of a typical installation of mechanical pressure filters for dealing with moorland water, namely, that belonging to the Ashton-under-Lyme, Stalybridge, and Dukinfield Water Board. He said that the advantages of pressure filters over sand filters included the following:—(1) The initial outlay was only about one-third of slow sand filters; (2) all discoloration could be removed by the addition of a coagulent; slow sand filters would quickly choke up under similar conditions and soon became inoperative; (3) pressure filters being enclosed no trouble need arise from the growth of algae nor from frost; (4) pressure filters occupied about one-fiftieth of the space required by slow sand filters; (5) the loss of head was negligible, being about 2 lb. when pressure filters were clean and 5 lb. to 6 lb. just before washing, whereas the head was lost entirely with sand filters.

With regard to the cost of working pressure filters as compared with slow sand filters, the author said that it was difficult to make a comparison because the conditions were so variable, but he quoted from a paper read by Mr. Ross, analyst to the Burnley Corporation, in which the latter stated that with pressure filters—including coagulents for removing colour—the cost worked out at 22s. 10½d. per million gallons, as compared with 33s. 3d. for slow sand filters. According to figures given by Mr. Dixon, engineer to the Ashton, Stalybridge, and Dukinfield Water Board, the average cost of treating four different kinds of water by means of pressure filters and chemical treatment worked out at 9s. 5d. for treatment and 14s. 4d. for capital expenditure, giving a total of 23s. 9d. per million gallons of water. In the foregoing figures the life of the pressure filters had been based on twenty to thirty years, as against forty to sixty years for slow sand filters.

The author concluded his paper with a reference to the use of pressure filters for industrial purposes to enable the dirtiest river water to be made clear and bright and suitable for every purpose, providing the hardness was not objectionable. For this purpose the same filter as previously described is used, with some form of chemical treatment. Each filter, 8 ft. diameter, would deal with from 5,000 to 10,000 gallons per hour.

The sun power plant, at Cairo, Egypt (described in the February 25 issue of the Contract Record), was the subject of an interesting paper read before the Manchester (Eng.) Association of Engineers last month by the inventor, Mr. Frank Shuman, of Tacony, Pa.

Increased Activity at Vancouver, B.C.

An Optimistic Outlook for the Constructional Interests—Progress Reports on the New Hotel Vancouver and other Large Buildings

Office of the Contract Record,
April 2, 1914.

VANCOUVER is undoubtedly entering upon a season of greater constructional activity than obtained last year, although it is possible that this may not be reflected in the building permits as the returns for last year included the figures for much important work which will be carried to completion this season. The outlook for the year is summed up for this journal by Building Inspector Jarrett in the following terms:

"It is a very difficult matter to predict the outcome of building operations at Vancouver for the year at this time, as there are so many varied conditions existing that have to be considered by the investor. Some of these conditions may improve very materially in a short time and relieve the situation very much, while others may continue as a check for the next few months. Still I am confident that 1914 will be a fairly prosperous year for the building trades here.

"One feature that stands out prominently is the number of fairly good dwelling house permits which have been issued since the beginning of the year. This indicates that our citizens have absolute faith in the future of the city.

"During the last three years a great many large mercantile and office buildings have been erected. While the demand for this class of building is fairly well supplied, I do not think that it is overdone; in fact to my mind there will be a continued demand for these two classes of buildings in Vancouver, though possibly not to the same extent as in the past few years. At the present time there unquestionably exist openings for several good hotel buildings. Quite a number are projected and have been placed in the hands of local architects.

"During the present year the construction of a considerable number of public buildings will be undertaken locally by the Dominion Government, and, in addition, a heavy volume of building construction is projected by the various railroad companies which make Vancouver their Pacific Coast terminus. The most encouraging feature of all, however, in the present situation is the marked increase in the number of enquiries as to warehouse and manufacturing accommodation within the city limits.

"Briefly summing up the conditions prevailing, I feel justified in predicting that 1914 will be a prosperous year for Vancouver and that it is only a question of a short time before we shall be back on the up grade again."

In no other part of Vancouver has constructional progress been more in evidence during the past few months than on the site of the Canadian Pacific Railway Company's new terminal improvement scheme at the foot of Granville Street. The new passenger station, included in the general scheme, which is being erected immediately east of the present passenger station is rapidly assuming shape, and a good idea is now conveyed of the imposing appearance which the building will present when finished. The construction consists of steel frame and reinforced concrete with pressed brick for the exterior facing and stone trimmings. An imposing row of Ionic columns which extend along the front elevation on Cordova Street lend an almost classic touch to the architecture, and the massive store cornices and the stone ornamental work also add a distinctive appearance. The exterior work is almost completed and it is anticipated that the structure will be ready for occupancy early in the coming summer.

The main entrance of the passenger station will be on Cordova Street with the main waiting room located centrally in the station on the street level. Ticket offices serving the several classes of railway and steamship passengers are located at one end of the waiting room, while the other service rooms are all placed immediately adjoining the main waiting room.

On the lower floors of the station are located the baggage rooms, express companies' space, immigrant rooms, supply rooms, and other station facilities not directly used by passengers. Stairways and lifts connect the two levels of the station, and also afford communication with the office floors above. A separate footbridge is carried over the passenger tracks, directly connected with the waiting room at one end and with stairways leading to the track level, giving access to platforms without crossing tracks at grade.

In connection with the improvements under way there will be four passenger tracks with provision for more when required, separated by wide platforms, between the station and the present freight yard. The passenger tracks are to be raised above the present track level to reduce the difference in level between the street and the tracks.

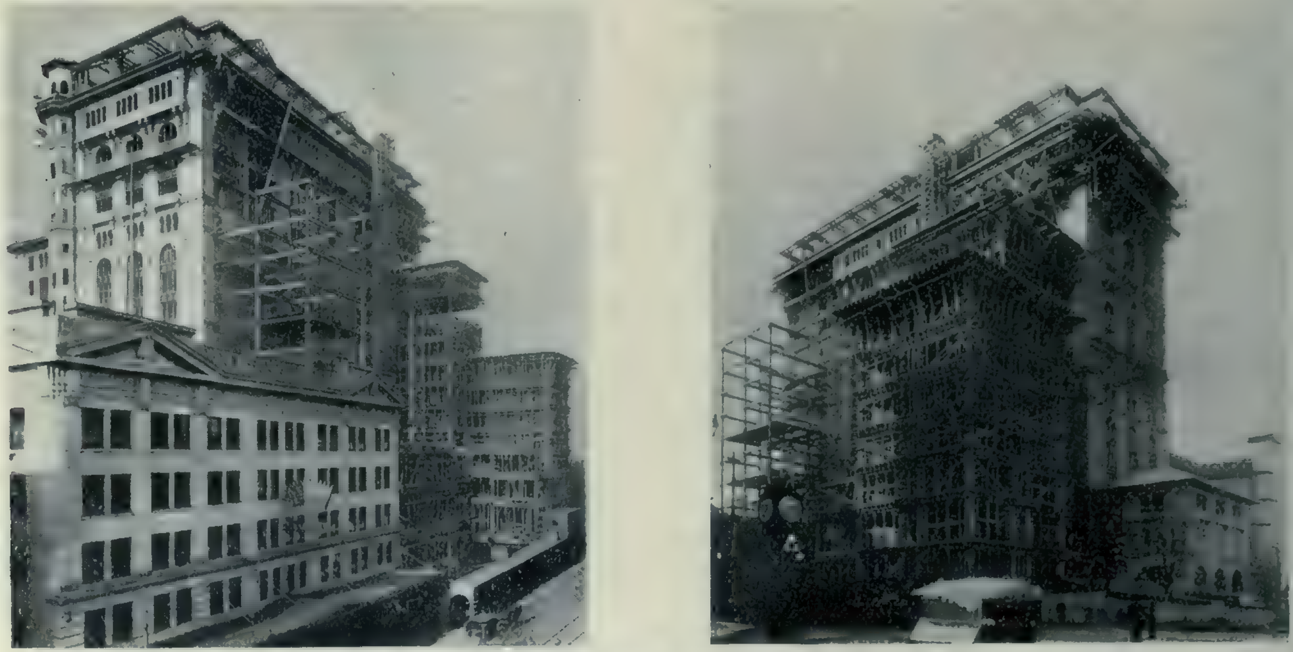
In order to avoid an inconvenient grade crossing and delays to traffic between the city and the company's steamship wharf, a bridge on the line of Granville street extended is to pass over the passenger and freight tracks to the steamship pier and connect directly with passenger accommodations on the pier. Gangs of workers are now engaged in laying the concrete foundations and piers for this viaduct. The footings between the tracks and at the waterfront landing of the bridge are also well on toward completion, and steel structural operations will likely be started from the dock end of the overhead bridge at an early date. The abutments have already been laid at the foot of Granville street in readiness for the viaduct. An incline is also to be built leading from the west side of this bridge to the wharf, giving access to the lower deck of the pier and freight sheds and to the water front. Construction is well advanced on the new steamship station which is being erected on the shore end of the pier for the B. C. coast steamship service. This will be a two-level building, the upper floor being devoted to the passenger business and offices and the lower floor freight, baggage and express.

Another viaduct over the tracks is being built on the line of Burrard street extending northerly with an incline giving access to the present Trans-Pacific pier and other portions of the water front. This important unit of the big scheme is now practically completed with the exception of the "ramp"—the inclined roadway which will lead to the dock level. The removal of the old Dominion Government immigration shed will be necessary before this viaduct can be completed.

The underlying principle of the general design has been to secure easy lines of communication between the railway trains, steamers and the city. The designs for the terminal were prepared by Messrs. Westinghouse, Church, Kerr & Company, of Montreal, Calgary and Vancouver, in co-operation with the officials of the C. P. R., and the construction of this station and facilities is now being carried out by the same organization.

The New Hotel Vancouver

The progress of construction has been very rapid on the Granville Street wing of the new Hotel Vancouver which is being erected at the corner of Georgia and Granville streets for the C. P. R. by the local contracting firm of Skene & Christie. All the steel and concrete work on the north portion of this wing is completed and a start has been made with the exterior facing. The building at this part is eleven storeys high where it adjoins the 16-storey central structure and rises to a height of seven storeys on the Granville Street frontage proper. The steel work is finished on the eleven-storey unit of the south wing and all concrete work is in place in the seven-storey section of this wing. At the present time the contractors are directing all their efforts towards the erection of the steel columns that will carry the cantilever beams over the billiard room and bar which will be located directly in the centre of this wing, in the basement. After these girders have been put in place a start will be made on the steel frame of the convention hall above the billiard room. These two rooms will each measure 50 x 100 feet. The steel work supporting this section of the building will have a 60-foot span, consisting of four girders of about ten tons each. The exterior facing in the main structure fronting on Georgia Street has been completed to a height of twelve storeys and steady progress is being made with the interior where operations are well advanced on the metal lathing, ornamental modelling, marble and tile work, plumbing, plastering, heating and ventilating, etc. The exterior of the handsome porte cochere on Georgia Street is completed and the contractors feel confident that the entire main section consisting of sixteen storeys will be finished by the 1st of July, when the business of the hotel will be moved into this part of the building and operations will be started on the re-modelling of the Howe Street wing. Work on this section will necessitate the demolition of the present six-storey office and rotunda portion and the erection of a new eleven-storey structure in its stead, to conform with the general architectural scheme followed on the Granville Street side. The entire hotel will be completed with the addition of one storey to that part of the Howe Street wing which is of comparatively recent construction. The exterior facing throughout is to be of pressed brick enriched with terra cotta. There will be 700 bedrooms altogether in the building, each having access to a private bathroom. A roof garden with pergola on the 16th storey, measuring 60 x 200 feet, will be one of the outstanding features. The hotel will contain eighteen electrically-operated elevators and when completely finished will compare favorably with the most ornate hotel structure on the continent. A force of four hundred men are constantly employed on the work. Mr. Francis S. Swales, architect for the C. P. R., designed the building on which the total outlay will amount to approximately $2,500,000.


On the left, a view of the New Hotel Vancouver from Granville street, showing four different stages of construction; on the right, a general view of the building.

The Weart Block Shaping Up Rapidly

The Canadian Ferro Concrete Company are making rapid headway with the construction of the Weart Block, the immense new office building which is being erected at the corner of Hastings and Richards Streets, Vancouver. Practically all of the exterior facing has been completed and the building is steadily assuming a finished appearance. This structure measures 78 x 120 feet and will be one of the largest office buildings in the province. It is fifteen storeys high and will contain thirty offices on the typical floor. The foundations have been carried to rock, 25 feet below grade, and the basement is fully waterproofed. The construction consists of a heavy steel frame and concrete, the exterior facing on the three lower storeys being terra cotta with a polished granite base. The succeeding eight storeys will be of face brick and the exterior of the four top storeys is to be treated in terra cotta. The spaces between the piers of the two lower storeys are to be finished in marble and bronze. The main entrance corridor has been designed in the same architectural style as the exterior, the walls and floors being or marble with bronze trimmings and ceilings of oak beams and panelling. The main floor is planned so that the corner can be utilized by a banking institution with the main entrance on Hastings Street.

The main corridor will be entered off a general vestibule which leads to the basement stairs on one side, and the bank entrance on the other. The corridor floors will be of terrazzo tile, with marble borders, and oak will be employed as interior finish throughout. An approximate expenditure of $700,000 has been estimated for the building, which was designed by Russell, Babcock & Rice, Vancouver. Mr. H. Van Matre is superintending building operations for the contracting firm.

The new Weart building, Vancouver, B.C.

The Hudson's Bay Store Addition

Thanks to the long spell of fine weather at Vancouver during the entire month of March the contractors for the Hudson's Bay store addition were enabled to make excellent progress with this building which is destined to be the handsomest structure of its kind at the Coast. The white terra cotta facing in the Georgia and Seymour street elevations is practically finished and good headway is being made with the pressed brick work in the remaining walls. As will be seen in the accompanying illustration the street frontages have been decorated with rows of Corinthian columns, suitably embellished, and disclose a dignified architectural treatment which is too often lacking in structures of this class. The construction consists of a massive reinforced concrete frame, in which there are over fifty vertical supporting columns each embedded in a concrete foundation which measures 8 feet square at the sub-basement floor, the columns themselves measuring 4 feet square and tapering two inches at every floor. The building occupies a site measuring 146 x 175 feet and is being erected strong enough to carry five additional storeys. The present structure forms only the first section of the departmental store which will ultimately occupy this site, plans being completed for a duplicate building with frontage on Georgia and Granville Streets. The total outlay contemplated will exceed $2,000,000. Messrs. Burke, Horwood & White, Toronto, are the architects and the work of construction is being carried on by Rourke, McDonald & Moncrieff, Vancouver.

The Hudson's Bay Company's new store addition, Vancouver. Note the contrast with the present store seen in the left-hand corner of the picture.

B. C. Telephone Company's Office Building

In pursuance of its general constructional programme, the British Columbia Telephone Company is now erecting on Seymour Street, Vancouver, between Georgia and Robson Streets, a new general office building in which provision will be made for three telephone exchanges the equipment of which will be of the most complete description. The steel frame work of this structure has been finished and the task of putting in the concrete for the basement and lower floors is proceeding steadily. The frontage on Seymour Street is 50 feet, and the depth to a lane, 120 feet. The type of construction to be adopted in this building is steel frame and reinforced concrete work, with pressed brick and terra cotta as exterior facing on the front elevation, and common brick for the side and rear elevations. The decorations of the main entrance will be in marble and tile. The head office of the Telephone Company will have accommodation in this building. Plans for the structure were prepared by Mr. J. Johnson, supervisor of the company's building department.

The contract for a new laundry building which the Cascade Laundry proposes to erect near the present premises in the 800 block, Beach Avenue, Vancouver, has been awarded to the Dominion Construction Company. The new structure is to be a three-storey building of reinforced concrete construction, costing approximately $40,000. It will occupy an area measuring 78 x 104 feet, and will be equipped with an elevator and laundry machinery of the most up-to-date description. Excavating operations on the site are completed and a start has been made with the general contract.

The congregation of Kitsilano Presbyterian Church have undertaken to engage in a campaign to raise the balance of a fund necessary to start construction of a new church building at the corner of Third Avenue and Vine Street. About $16,000 has already been pledged. The building will cost about $65,000 and it is desired to increase the guaranteed subscriptions to $40,000 before undertaking a contract.

Excavation work on the site of the new city hall at Port Moody was completed recently and a start has been made on the construction of the building itself. According to the plans the structure will have a concrete foundation, and will be one and a half storeys high with basement. It will cover an area 74 x 42 feet. The accommodations will include a council chamber, offices of the mayor, clerk, assessor and engineer, court room and engineer's room, police office and cells. The completed structure will cost approximately $10,000 and will be executed by day labor. Mr.

J. H. Bowman is the architect, and the work of construction is being superintended by Mr. Hugh Kerr.

Mr. J. J. Donnellan, a Vancouver architect, has been commissioned to prepare plans for a modern theatre building to be erected in Vancouver for Mr. Alexander Pantages. Constructional details are not available for publication, but work will be undertaken as soon as the necessary preliminary steps are completed. It is understood that Mr. Pantages recently purchased a site in the central part of the city and that while the building will be an addition to the structure now on the property, it will comprise a modern down-town theatre as well as a business office block of the first class.

Plans are being prepared for extensive alterations and additions to the present Orange Hall building at the corner of Hastings Street east and Gore Avenue, Vancouver. It is also the intention of the Society to erect a two-storey lodge hall in the Grandview district for which $18,000 to $20,000 will be appropriated. The additions contemplated to the building on Hastings Street and Gore Avenue will include the erection of two more storeys, making five in all, provisions for an elevator, changing the entrance and other extensive alterations. It is estimated that this contract will run about $40,000.

Important Dock Contract

Evans, Coleman & Evans, Vancouver, have been awarded the contract for a large dock which McNeil Welsh & Wilson, Limited, propose to build on the south side of False Creek, Vancouver, adjoining the G. N. R. bridge. The preliminary work will comprise the erection of a wharf 308 feet long, 176 feet wide, approached by a roadway 200 feet in length, and the reclamation of a tract between the proposed dock and the railway bridge. Separate tenders for the erection of sheds and warehouse buildings will be called when the main portion of the new dock is built. The plans provide for two large buildings 204 x 75 feet, which will flank a central roadway and gridiron landing slip for scows. Additional loading facilities for barges will be provided on the western side of the wharf, and the reclaimed area between the eastern edge of the dock and the railway bridge will be utilized for trackage purposes. A strip 50 feet wide will be filled in to connect the dock with the bridge. The warehouses will be of timber with trussed roof, faced with galvanized iron. The roadway and the scow landings will also be enclosed. Messrs. J. P. Matheson & Son, architects, Vancouver, prepared the plans for the project. The property which is to be developed has 600 feet of water-frontage, extends 400 feet out from the shore into deep water, and has an area of three and a quarter acres. The company intend to use about one-third of the tract now and the rest later. The dock at first will be used by the Great Northern Express and Transfer Company, and its subsidiary concern, the Vancouver Coal Company, of which the new corporation is an amalagamation. Mr. J. D. McNeill is president and managing director of the former, Mr. Nelson Welsh is manager of the allied companies and Mr. W. H. Wilson is secretary-treasurer. The company plans to enter the ocean shipping business and to engage in a general building supplies business at a later date.

The City Commissioners of Saskatoon are considering suggestions offered by Mr. E. Hanson, city electrical superintendent, with regard to the alteration of the present system of pumping the city's water supply. The plan is to utilize the water which it is necessary to pass through the condenser at the power house—some 6,000,000 gallons every twenty-four hours—and instead of returning it to the river to pipe it into a sedimentation basin, filter and use it for domestic purposes. This would render unnecessary a separate pumping plant.

Personal Mention

Messrs. Ross & MacDonald, architects, have moved their western offices from 928 Union Bank Building to 506 Tribune Building, Winnipeg.

Mr. William Pearson was re-elected president of the Winnipeg Housing and Town Planning Association at the first annual meeting on March 24.

Mr. H. Galloway, a well-known Edmonton contractor, has secured an important contract in Kentucky, where he has had considerable experience.

Mr. H. Cameron, who has just arrived in this country from Glasgow, has taken up his duties as assistant manager of Canadian Vickers, Limited, Maisonneuve, P.Q.

Mr. R. P. Blakey, government architect for the province of Alberta, visited Toronto recently in connection with plans which he is preparing for a new prison in Alberta.

Mr. A. M. Bennyman, a well-known resident of Amherst, and for some time superintendent with the Robb Engineering Company, passed away on March 25 at the age of 57 years.

Mr. Vernon C. Lucknow, consulting engineer, Victoria, B.C., visited Toronto last week on business relating to the construction of a new store building at Victoria for the Hudson Bay Company.

Mr. R. Preston, master mechanic of the Canadian Pacific Railway, at Winnipeg, has been promoted assistant superintendent of motive power of the lines west of Winnipeg, with headquarters at the latter centre.

Mr. H. D. Johnson has been appointed to the engineering staff of the Eugene F. Phillips Electrical Works, Limited, of Montreal, as assistant contracting manager. He was formerly with the Canadian-British Insulated Company, Limited.

Mr. J. E. Huot, architect, who has been in practice in Montreal, has joined the firm of Wadsworth & Henderson, architects, the new partnership being known as Huot, Wadsworth & Henderson. The offices are in the New Birks Building, Montreal.

Mr. L. C. Frith, chief engineer of the Chicago Great Western Railway, took up duties on April 1 as assistant to the President of the Canadian Northern Railway. Mr. Frith, whose office will be in Toronto, is a graduate of the University of Cincinnati.

Mr. W. C. Willard, recently Assistant Engineer, Panama Pacific International Exposition Company, has been appointed assistant professor of railway engineering at McGill University, Montreal. Mr. Willard had charge of the design of sewer system of the exposition.

Mr. George H. Strevel, a pioneer citizen of Winnipeg and at one time the foremost railway contractor in western Canada, died at Winnipeg on March 16. Born March, 1836, he was a native of Brighton, Ont., and going into contracting he became one of the pioneer railway builders of western Canada.

Mr. Stewart, of the firm of Messrs. Phillip, Stewart and Lee of Saskatoon, contributed a paper at the March meeting of the Victoria branch of the Canadian Society of Civil Engineers, on the subject of "Construction and Design of open Bridges," referring particularly to the drainage work done in Saskatoon and the machinery most suitable for this particular work.

Mr. A. Charlebois, a contractor formerly of Quebec city, passed away suddenly on March 23 at Montreal. He was one of the best known contractors in the Province of Quebec, having carried out the contract for the building of the east wing, which contains the legislative council and legislative assembly of Quebec, as well as the stone wall which surrounds the grounds.

Mr. Morris A. Zook, consulting engineer, of Plainfield, N.J., recently engineer in charge of the valuation of the Grand Trunk-Wabash joint lines in Canada, has been appointed resident engineer of the division of valuation, Interstate Commerce Commission, with office at Washington, D.C. Since 1904 he has been in private practice, mostly in railway valuation work.

Mr. E. B. Temple, of Toronto, died recently in his seventy-seventh year. The late Mr. Temple took an active part in the construction of the Grand Trunk Railway between Montreal and Quebec, and subsequently he was attached to the Toronto staff of the Canadian Pacific Railway. Some years later he was appointed by the Government to take charge of the harbor development and general waterfront construction work at Toronto, during which he supervised the construction of the walls and cribwalks of the Eastern Gap. He was a member of the Canadian Society of Civil Engineers and also of the Institution of Civil Engineers of Great Britain.

Mr. J. D. McArthur, railway contractor, who is building the Edmonton Dunvegan and British Columbia Railway has subscribed $5,000 and promised an additional $15,000 next year to the Edmonton Industrial. This and other subscriptions are to be contributed to the fund for developing the Viking Gas Field, upon which operations have been commenced by the International Supply Company of Medicine Hat.

Mr. J. W. Dudley Robinson, B.Sc. (Lond.), has been appointed Secretary of the Institution of Municipal and County Engineers (London, Eng.), at a salary of £400 per annum. Mr. Robinson is twenty-eight years of age and was educated at the Mathematical School, Rochester, and the South-Western Polytechnic Institute. To enter upon his new position he resigns a secretaryship in the central offices of the University of London.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The County Council of Oxford has decided to prepare a by-law to raise by debentures the sum of $50,000 for county road construction during 1914.

Messrs. B. Mooney & Sons are the contractors for the new building for the Bank of British North America which is nearing completion at St. John, N.B.

Among recent contracts of considerable magnitude mention must be made of the Severn Division of the Trent Valley Canal awarded last week to the Inland Construction Company, Toronto, at $712,258.

A contract has been let for the supply of the DeVigan brand of Caen stone cement plaster to be used in the palm room of Sir Henry Pellatt's residence, Toronto, of which Mr. E. J. Lennox is architect.

Second tenders have been called for the $400,000 college which is to be erected by the Loyola College, Montreal. The architects are Messrs. Peden & McLaren and the closing date is April 17. The structure is to be of stone and fireproof construction.

Montreal's building permits from January 1 to March 31 represent an expenditure of $1,855,196, divided among 580 permits. In the corresponding period of last year the total was $1,867,847 and the permits were 742. March, 1914, shows an appreciable gain over March of last year, the returns being $949,496 and $761,550.

Permits totalling in value $94,811 were issued in Guelph during March as compared with $39,500 for the same month last year. This brings the total for the first three months of 1914 to $154,189, as against $97,455, which goes to indicate that a record in building construction in Guelph will take place during the present year.

Mr. J. E. Armstrong, of East Lambton is arranging for a deputation to approach the Minister of Public Works at Ottawa with regard to the question of drawing supplies of road gravel for Western Ontario from the River St. Clair at Sarnia. The farmers in the township of Enniskillen have offered to haul the gravel free from the railroad sidings and to distribute it.

The Board of Trade, Council and Commissioners of St. John, N.B., have decided to send a deputation to Ottawa to urge further federal aid for the projected bridges across the St. John and Kennebeccasis Rivers. The cost of the project is estimated at nearly $3,000,000, and the Federal Government has already pledged a grant of a million dollars towards the construction.

It is announced that the proceedings of the Commission appointed to investigate the commercial feasibility of the proposed Georgian Bay Canal will be made public, and that the information collected will be given out from time to time. Mr. J. P. Hepbourne, for many years connected with the Great Lakes and transportation matters, has been appointed secretary and will have an office at Ottawa.

A new style of portable metal buildings, particularly adapted to the requirements of contractors and engineers, is being manufactured by the Pedlar People of Oshawa. These structures are made of the highest grade materials, either all-steel or metal-clad. They are easily transported from place to place and afford protection against fire in out-of-the-way places. They are particularly suitable for railway buildings, such as tool-houses, shelters, freight-sheds, and so on. Additions can be made in eight-foot lengths.

Mr. J. G. Carey, C.E., of the firm of Carey and Chase, addressed the Civil Engineers' Club in the mining building of Toronto University on March 26, his subject being "Moose Factory as the terminal of the Timiskaming and Northern Ontario Railway." He pointed out that besides the projected line of the Ontario Government to Moose Factory, the Manitoba Government contemplated constructing a line east from Winnipeg to Port Nelson, and the Quebec Government will lay a line from Montreal to Rupert House.

The number of building permits issued from the city architect's department, Toronto, during March, 1914, totalled 638, representing 996 new buildings at a value of $2,550,075. The total for the three months of the present year is returned at $4,598,685. The permits issued during March, 1913, were 515, representing 795 buildings and a money value of $2,066,285. The value of the permits issued for the first three months of 1913 was $4,891,579, which shows a reduction of $292,894 on that for the corresponding period of last year.

Mr. J. K. L. Ross has made an offer to the hospital authorities of Montreal to contribute the balance of between $250,000 and $300,000 to erect and endow a new private pavilion in connection with the Royal Victoria Hospital, for which a few thousand dollars had already been subscribed. The new pavilion will be erected immediately behind the main building and will be a separate structure probably with a covered passage connecting it with the hospital proper. Architectural plans will be called for immediately and construction started as early as possible.

Mr. J. R. Ambrose, chief engineer for the Toronto Terminal Railway Company, will open tenders this week for the building of the new Union Station. The officials claim that it will take about two weeks to consider the contracts before they are awarded . This means that the work cannot be started until the end of April. The officials of both the G. T. R. and C. P. R., with their architects, have agreed on the details of the plans. The consulting engineers are Chief Engineers H. R. Safford and J. M. R. Fairbairn of the G. T. R. and the chief engineers of the Canadian Pacific Railway.

Mr. A. D. Swan, member of the Institute of Civil Engineers, who recently enquired into the suitability of the St. Croix River, Charlotte County, N.B., for a deep water harbor which would be open all the year round for merchant shipping of the largest class, has reported to Hon. Robert Rogers, Minister of Public Works, recommending that wharf areas, railway terminals, road and freight handling facilities in general, should be designed on a comprehensive, practicable scale and constructed by degrees at Oak Bay at a cost, not including purchase of site, of about $2,250,000.

By a majority of 1,308, the citizens of Ottawa have approved by plebiscite the Currie-McVeity water supply scheme, which provides for rapid sand mechanical filtration of the water from the Ottawa River. The total vote in favor of this scheme was 7,544 and for the 31-mile lake, 6,236. The source of supply in the approved scheme is a point above the Chaudiere rapids where contamination is practically nil. From a point in the Little Chaudiere and the Remic rapids two intake pipes will convey the water to a pumping station with electrically driven pumps. From here the water will be forced to the purification plant and reservoir which it is proposed to establish. The system of purification includes sedimentation and coagulating basins through which the water will flow by gravitation to the sand filter beds and through it into the pure water reservoir, designed for a capacity of 10,000,000 gals. of filtered water. The total estimated cost of the plant, together with engineering expenses, etc., is $1,700,000.

St. John, N.B., is making much progress as illustrated by the extensive harbor developments, the establishment of new industries and the enlargement of its housing accommodation. The city and county are to erect this year a hospital for advanced cases of tuberculosis at a cost of $85,000 and the municipality has also secured authority from the Provincial Legislature to make a large bond issue to erect a general hospital. The work of remodelling the larger building at the corner of King and Jermain streets, to be used solely by the Canadian Pacific Railway and the Dominion Express Companies, is now in progress, and when the work is complete the Canadian Pacific will have extensive general offices for all its departments under one roof. The steel frame of the new post office is now completed and the work of the outer walls and interior will be finished in the spring and summer months. Mr. W. U. Humfray, an English capitalist, who has made large investments in St. John, has brought from England the information that representatives of three large manufacturing concerns are coming to St. John to look into the question, selecting that city as the site for the location of branch factories for Canadian business. If this scheme materializes it should mean much industrial expansion for St. John.

WESTERN CANADA

If the plans of the Empire Theatre materialize, the city of Edmonton will have another ten-storey office building at a cost of $600,000.

At Edmonton, Alta., an eight-storey addition is to be built by the Y. M. C. A. at a cost of $400,000. Messrs. Magoon & MacDonald are the architects.

The town of Kindersley, Sask., is making preliminary surveys for a reservoir estimated to cost $125,000. Operations will not be commenced this year.

Operations are to be resumed on the club and apartment house for the Northern Club, Edmonton, Alta. The building will be seven storeys high, of steel construction, and will cost $250,000.

During the summer, Messrs. R. J. Lecky & Company will build the superstructure of the new traffic bridge across the Saskatchewan river at Saskatoon. The cost of the bridge is placed at $398,000.

Plans are being prepared for a new bank building, estimated to cost $250,000, at Edmonton, for the Bank of Alberta. The structure will be six storeys high, of granite construction finished in marble.

The Saskatoon builders' exchange passed a resolution recently requesting the city council to appoint a city engineer forthwith, who would have charge of all construction contracts and report direct to the Mayor and city council.

It is reported that the public works department of the Dominion Government have purchased a lot and water frontage out to Channel Bank at Port Lambton, with the intention of constructing a landing and a customs and immigration office.

A new public school is being erected at Swift Current, Sask., by Messrs. Reid, McDonald & Brewster, of Edmonton, Alta., at a cost of $155,000. The heating and plumbing contract has been let to Messrs. Frost Brothers, of Swift Current and Moose Jaw.

Mr. W. E. Cox, a Winnipeg engineer, advocates the vacuum steam heating system which he contends would effect a saving of at least 10 per cent. in cost of coal consumption in the new Mayfair school in course of erection. The system has been tried in a number of Canadian cities with gratifying results.

Messrs. Carter, Halls & Aldinger are making good progress with the erection of the new Winnipeg building for the Bank of Quebec. The building is four storeys high, of steel and concrete construction, and involves a cost of $225,000. Messrs. Brown & Vallance, Montreal and Winnipeg, are the architects.

"Carelessness in building construction is the chief cause of Saskatchewan fire losses" said Mr. R. J. McLean, provincial fire commissioner, at Regina recently. He also stated that the municipality which insists on rigid enforcement of the regulations for the protection of property from fire might bring about a substantial reduction in insurance rates.

A new warehouse and office building has been completed for the Massey-Harris Company, on Eleventh Avenue, Calgary. It is a handsome four-storey, solid brick building and will be the future home of the Calgary branch of the Massey-Harris Company. Mr. D. H. MacKay was the supervising architect and the Union Building Company of Calgary, contractors.

City Engineer Rust has returned to Victoria, B.C., after a trip to Seattle, where he inspected the method by which the pavement on streets on which car-tracks are laid, is protected. A new type of paving brick is now being manufactured there and it is the intention to use vitrified paving brick or wood blocks alongside the street-car tracks on all future pavements.

The contractors are working two shifts daily on the construction of the 25th Street bridge at Saskatoon, and also on the fifth pier. An immense cable has been stretched across the river slightly to the south of the piers and to this will be attached scows for use in building the sixth pier in midstream, the construction of which proves to be the most difficult problem with which the contractors are faced.

The construction of the new 2,000-ton smelter for the Granby interest at Goose Bay, B.C., was completed recently and everything is in running order in preparation for the continuous smelting of that valuable copper ore known as the Hidden Creek property. The announcement was made by Mr. F. M. Sylvester, manager, that four hundred men will be employed to run the smelter, and a similar number in the mine.

Mr. J. P. Forde, district engineer of Revelstoke, B.C., made the announcement that with the exception of the wharf at Kaslo, and the new wharf at Ainsworth which is to be constructed of cement, the Dominion public works department has practically completed its winter programme on Kootenay Lake and the west arm. Mr. J. Dancy, of Nelson, is the contractor for the cement wharf at Ainsworth, which promises to be one of the finest structures of the kind in British Columbia.

Dr. M. H. Seymour, commissioner of public health for Saskatchewan has written Saskatoon city officials stating that he must refuse to sanction any more sewer extensions this year unless the city starts the construction of a sewerage disposal plant, which will obviate the necessity of depositing sewage untreated into the South Saskatchewan river. The city, recognizing the need for a sewage disposal works, have already purchased a site and the greater part of an intercepting sewer has been constructed at a cost of over $300,000.

As the outcome of a discussion between a deputation from Coquitlam municipality and the members of the Burnaby waterworks, the municipality will request the Railway Commission for its sanction to a level crossing over the Great Northern Railway tracks. Mr. F. M. MacPherson planned to raise the present bridge 6 ft. and to make the necessary fills for the new grade. The high-level steel bridge ordered by the Railway Commission last year has yet to be built, but drawings of a superstructure will be submitted at once for selection.

Civic improvements under way at Vancouver will cost approximately $20,000,000, all of which at the present rate of construction will be expended within the next two or three years. Plans for the construction of a railway bridge across Burrard Inlet to North Vancouver, which will cost an additional two and a half million dollars, have been approved by the Dominion Government. The money for this project is already provided and work will be commenced this spring. The cost of construction will be shared by the Dominion and Provincial governments.

The first annual meeting of the Winnipeg Housing and Town Planning Association, which was held on March 24 under the presidency of Mr. William Pearson, decided by unanimous vote to affiliate with the industrial bureau, continuing, however, under its present form of organization. All work undertaken in connection with housing and town planning will be carried on in the name of the Winnipeg Town Planning Association of the Industrial Bureau. Mr. J. D. Atchison pledged the system to stand behind a request to be made to the city council for the passing of legislation providing for a limit to the height of all future buildings in Winnipeg.

The Elm Park Company's new steel bridge connecting Elm Park with the city of Winnipeg, was opened for traffic on March 14. The substructure consists of concrete piers, abutments, etc. The steel superstructure, which was erected by the Dominion Bridge Company, Limited, consists of a swing span 278 ft. long, a fixed span 222 ft. long and an approach on the south side about 100 ft. long. It has a 16 ft. roadway and an 8 ft. sidewalk. The floor of the bridge is about 25 ft. above the summer water level in the Red River, consequently it will only be necessary to open the swing span for the largest passenger steamboats. The entire work in connection with the bridge has been carried out under the supervision of Professor E. Brydone-Jack as consulting engineer, and Mr. A. S. Innes as field engineer. The total cost of the structure will be about $125,000. Messrs. Fowler & Young were the contractors.

In a recent issue of this journal it was announced in the Contracting Department that the Union Contracting Company, Limited, had been awarded the contract for four viaducts at Vancouver, estimated to cost $300,000. At our request the Supervising City Engineer, Mr. F. L. Fellowes, has very kindly furnished details on this project. These viaducts are to be built according to the "Mushroom" system of reinforced concrete. They are designed and are being built to eliminate the level crossing at Hastings, Pender, Keefer and Harris streets, over the Great Northern Railway Company's right-of-way. The cost devolves mostly upon the Railway Grade Crossing Fund and the Victoria, Vancouver and Eastern Railway Company. The B. C. E. R. Company and the city are also interested. Maintenance is divided equally between the city and the Victoria, Vancouver and Eastern Railway Company. The bridges on Harris and Hastings streets will be double-tracked for the B. C. E. R. Company, who operate the street car service at Vancouver. The designs were prepared by the City Engineer's staff with Mr. Turner in a consulting capacity.

Mr. H. W. Bassett, a partner in the firm of Messrs. Grant, Smith & McDonnell, to which the Dominion Government has awarded a $2,250,000 contract for the construction of the proposed ocean docks at Victoria, made a personal inspection of the sites recently and announced that before long plans will be assembled for the commencement of operations. Office quarters for the clerical staff will be erected on Dallas Road convenient to the work. Local labor and home manufactured equipment will be employed as far as possible. According to Mr. Bassett, the material to be used in the wharves will consist of reinforced steel, cement, lumber, rock, sand and gravel. The firm of Messrs. Grant, Smith & McDonnell has been identified with various important constructional undertakings including the boring of a tunnel from the Catskill Mountains into New York, the contract involving an expenditure of five million dollars, and which is almost completed. The company was also engaged in a large amount of double tracking on the British Columbia line of the Canadian Pacific Railway. Apart from this work the firm have also carried out much of the grading of the Canadian Northern Pacific Railway, one of its first undertakings on Vancouver Island having been in connection with the local section of the C. N. R's. road.

Canadian Railroad Development

In connection with the proposed line for the Calgary and Fernie Railway, five parties of engineers are said to be in the field surveying routes for extensions north and south and branches east and west. The charter for the Calgary-Fernie line was secured by a concern known as the Grain Belt Company, composed of Eastern Canadian and London financiers, and the route is understood to be ready for contractors to commence construction.

The American Car Company have constructed a number of tank cars especially equipped for fire-fighting, to the design and order of the Canadian Pacific Railway. The idea, which is a new departure on the part of the Canadian Pacific Railway, is to operate the cars in pairs each car carrying a tank of 8,438 Imp. gallons and on the end of each car there is a 20 in. x 10 in. duplex fire pump using steam from the locomotive boiler. At the other end is a rack construction on which can be carried 6,000 ft. of fire hose. The car is designed for weight capacity of 100,000 lbs. and Standard 50-ton trucks are employed.

The Grand Trunk Pacific Railway's building schemes at Prince Rupert, B.C., are being steadily advanced. Some of the larger works with their estimated cost at completion include the following:—Dry dock $2,750,000; fifteen-storey hotel $2,000,000; terminal facilities, including docks, depots, shops, etc., $2,500,000, for the Dominion Government; post office $250,000; court house and administration office building $300,000; hydro-electric plant (first unit) $380,000; sewerage system and waterworks extension $500,000; section two bridge, erected by the Imperial Oil Company $100,000; five large storage tanks $200,000; making a total of $9,180,000.

The Canadian Pacific Railway is engaged in completing its line from Golden to Fort Steele in the mining country of British Columbia. The company expects to operate trains over it by the end of the summer in order to open up the valley of the Kootenay and Columbia River, which contains valuable silver and lead ore deposits. The five-mile tunnel through the Selkirk Mountains at Rogers Pass, when completed some time next year, will eliminate about four-and-a-half miles of snow sheds and heavy gradients. The tunnel will give the company practically 2.2 per cent. grade through the mountains and an almost water level route from the Pass to the Vancouver terminals.

Work on the C. N. R. bridges from Montreal to Pembroke is now ready for steel according to an anouncement made recently by Colonel Greenwood, assistant chief engineer of construction. The two bridges across the River des Prairies have eight piers and four abutments and the large structure across Mille Isle river has fourteen piers and two abutments. The masonry work has been completed and the bridge companies have already begun work on the superstructures. Between Ottawa and Pembroke the Ottawa river is crossed twice, at Fitzroy harbor and at Portage du Fort, by bridges of 1600 and 1800 ft., respectively. The last-named bridge has three spans of the superstructure in position. The contract for grading, bridge-building and track-laying from Montreal to Hawkesbury and from the Capital to Pembroke is being carried out by Mr. J. P. Mularky.

One of the officials of the Pacific Great Eastern Railway Company made the announcement a few days ago that the survey of the Peace River extension of their line had already commenced. The Lieutenant-Governor of Victoria has given his assent to the act passed at the last session of the Provincial legislature, authorizing the construction of the road and guaranteeing the company's bond to the extent of $35,000 a mile, the terms of the contract requiring the starting of operations within three months. The line is to penetrate a distance of 330 miles into the Northland to the eastern boundary of the province. Regarding the main line between Clinton and Fort George, where a junction is to be affected with the Grand Trunk Pacific Railway, it is announced that preliminaries will be completed shortly, when the entire project from Vancouver to the junctional point will be in the hands of representatives of the contractor. The February report regarding the right-of-way from the Coast to Clinton indicates that about 4,000 men have been engaged.

Construction work is now proceeding on that portion of the Kettle Valley railway, which will link up the Canadian line with the V. V. & E., at Princeton. Authorization for a change in the route as originally planned was given at the recent session of the Provincial legislature, the change being previously approved by the Dominion government. Pending this decision a ten-mile section has been commenced which will form part of either the original or the proposed new route, and at present gangs are at work over the remaining 23 miles of the 33-mile section between Osprey Lake and Princeton. The provisions of the Kettle Valley railway bill which was recently passed by the province, relieved the company from constructing its line to Otter Summit from Osprey Lake, the Kettle Valley having arranged for using the V. V. & E., via Princeton to the former point. A similar agreement exists between the two railways with respect to the use of the section between Coquahalla Summit and Hope. Work is said to be well advanced on the latter portion of the Hope Mountain route. About 1,600 men are employed on the grading operations on the joint section.

An official of the Canadian Pacific Railway, who has just completed an extended tour of the Canadian West and the northwest section of the United States, reports that business conditions in these territories are essentially sound; that the western business man is building carefully and conscientiously toward future prosperity and is in practically every sense becoming as much a man of affairs as is the easterner; that Vancouver is preparing actively for the opening of the Panama Canal and that business generally is expanding. In the words of this official, Vancouver is probably doing more than any other Pacific coast city towards preparing for the traffic certain to follow the opening of the Panama Canal. Government and private capital is being liberally expended to make it one of the best ports on the Pacific seaboard. Among other important operations under way is the Canadian Pacific Railway's new terminal for trains and vessels, which will cost more than $3,500,000. The terminal with most of its adjuncts, such as siding yards, round house and repair shops, will be completed some time this year. The new $2,000,000 hotel now being erected by the Canadian Pacific is nearing completion.

The 1914 edition of "5000 Facts about Canada," compiled by Frank Yeigh, contains much that is interesting and instructive to the constructional world. Mr. Yeigh's researches appear to have been carried out in all the multitudinous byways of human activity and there appear to be few shortcomings—none that we can find—in his excellent publication. There are facts about the cities and the provinces, individually and collectively; there are facts about the natural resources of the country and of the various branches of constructional development; there are trade facts, banking facts, population facts and all the other facts which go to make up an encyclopedia of information expressed within the dimensions of a volume which may be carried in the vest pocket. The publishers are the Canadian Facts Publishing Company. 588 Huron Street, Toronto.

ESTABLISHED 1886

Contract Record
and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 April 15, 1914 **No. 15**

Principal Contents

Thirty Million Dollars for Ontario Good Roads 443
Is Upward Hydrostatic Pressure or Low Coefficient of Friction Responsible for Recent Dam Failures? 444-5
Cost-Keeping on Constructional Work 445-7
By G. L. Shanks
The Administration of Municipal Public Works, especially relating to Highways 447-9
By Nelson P. Lewis
Construction Plant and Methods Employed in Placing the Cofferdam for the new Intake Tower of St. Louis Waterworks 449-454
The Georgian Bay Ship Canal—Its proposed Route and Its Economic Importance 455-6
By Sir Robert Perks, Bart.
Systematic Refuse Disposal for Small Cities and Towns 457-8
By Samuel A. Greeley
Sanatorium at Fort Qu'Appelle, Sask. 458
Structural Features of New Toronto Theatre 459-60
(Staff article)
How Bridges Expand 460
The Kilgard Fire Clay Company's Plant at Kilgard, B.C. 461-5
(Staff article)
Brick Pavements as an Investment 465
By W. T. Blackburn
Suspension Bridge at New Hazelton, B.C. 466
Letters to the Editor 467
(Philip J. Turner, F.R.I.B.A., and E. D. Tuttle)
Personal Mention 468
George Smith, Town Engineer, Midland, Ont.—Biographical Sketch 469
Constructional and Industrial News 470-3
Montreal Road Congress 473
Publications Received 473

Thirty Million Dollars for Ontario Good Roads

In connection with constructional development it may be affirmed truly that road building plays a most important part in the larger aspect of the country's growth. This is a trite observation but a none the less significant one on that account. In all ages, in every historical period, great nation-builders have been great road-builders. The roads constructed by the men who built up the great Roman empire survive today. Transportation facilities in the shape of good highways are the alpha and the omega in the attainment of industrial and national supremacy. In the wake of good roads follow all other forms of constructional activity. Farmers are assisted greatly in the ready marketing of their products and this induces a more rapid circulation of money, which in turn enables those identified with manufacturing to carry out their programmes of extension or to supply funds for the exploitation of the new territories opened up by the highways. Hard upon good roads follow settlements, villages, towns and cities, with the attendant developments in the way of buildings of all kinds—sewerage, waterworks and power.

With these convictions one cannot but regard with the greatest satisfaction and optimism the scheme contemplated in the report of the Ontario Highways Commission submitted to the legislature last week. This report recommends the expenditure of no less a sum than $30,000,000 on the market and trunk roads of Ontario during the next fifteen years. The report is a comprehensive one and deals with every phase of administrative detail. Briefly it is suggested that the provinces contribute $12,000,000, the counties $12,000,000 and the cities $6,000,000, such obligation being incurred gradually during a period of fifteen years from 1915 to 1930. The Commission realize that the extension of definite plans beyond that period would be inadvisable in view of the transitional stage in which traffic conditions and highway construction are at present. It is of interest to note that it is proposed to devote a portion of the funds to townships which are saddled with heavy expenditures on bridge work.

With the road system of the province entirely reorganized and the work in charge of a Minister, with a deputy and three advisers, as suggested, it is fair to look for unprecedented activity in Ontario during the next decade. It is not so much the amount which the scheme calls for—although this in itself is a consideration which should not be overlooked by those identified with the field in any way. Apart from the direct benefit which will accrue from the work there is the indirect benefit that will come from the example of putting such a progressive policy into effect. It is still another proof that the provinces of the country have a sure confidence in their individual destinies and are willing to translate that confidence into physical properties and millions of dollars, just as, in the wider aspect, the country itself spends hundreds of millions in the construction of railroads, anticipating the day not far distant when the towns will have become cities and the cities have assumed metropolitan proportions.

The administrative details of Ontario's road scheme have been carefully planned and the expenditure distributed wisely, so that there need be no apprehension in regard to the financing of the undertaking. It is sufficient to retain the central idea of the provincial government's example in undertaking the expenditure of $30,000,000 on road work and to consider the general effect of such a policy in engineering and general constructional development.

Is Upward Hydrostatic Pressure or Low Coefficient of Friction Responsible for Recent Dam Failures? *

IT seems clear that one of two causes, or possibly a combination of the two, is responsible for many failures of masonry dams founded on rock: (1) Upward hydrostatic pressure on the base of the dam; (2) Low coefficient of sliding friction.

The theory of upward hydrostatic pressure assumes that the pressure increases uniformly from zero at the down stream toe of the dam to a pressure due to the full head of water at the upstream heel of the dam. But, upon what tests is this theory based? If the rock under the dam contains vertical fissures and is otherwise impervious, theory would indicate that the upward pressure would not exceed that due to the cross-section area of the vertical fissures. If there are also horizontal fissures beneath the dam, then the cross-section area of these also must be taken into consideration. Let us assume, however, that there are no fissures worthy of consideration, but that the rock beneath the dam is very porous, and that water flows steadily through these pores or voids. This is evidently the tacit assumption underlying the theory that the upward pressure increases uniformly from zero at the toe to full pressure due to the head at the heel of the dam. Is it not clear that if this is the case the total area of dam base is not under pressure? Are not the voids in the rock so many small pipes, and is not the combined cross-section area of these pipes far less than the area of the base of the dam? An affirmative answer seems imperative, but once this is conceded the upward pressure theory loses most of its weight.

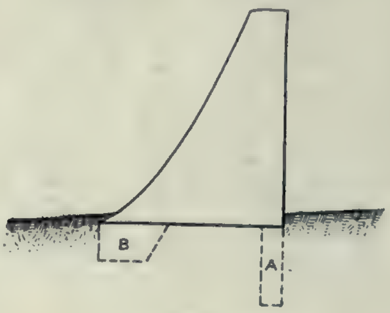


Fig. 1.

This, however, is not the only defect in the upward pressure theory. When water comes in contact with a solid, it adheres to the solid by virtue of molecular attraction between the solid and the water. In voids of capillary size this molecular force becomes of exceeding importance. It is this force, for example, that makes wet sand on a sea beach adhere so that it forms a good road, although the same sand when dry falls apart and will not support a wheeled vehicle without much displacement. What is the effect of the molecular attraction between water and the walls of capillary tubes through which it flows? Can anyone affirm that it does not greatly reduce the upward pressure on a dam founded on rock containing pores through which water flows? We know of not a single experiment that can be appealed to in answering these questions.

Here, it seems to us, is an excellent theme for an engineering student's thesis—indeed for many a thesis. At least some of the fundamental principles can be solved by quite simple experiments on a small scale. As matters now stand, engineers do not know even the fundamental principles of hydrostatic pressure of water in porous solids underlying dams.

There is an equally fruitful field for experiment on the coefficient of sliding friction of rock and earthy materials. Experimental data on this subject are lamentably inadequate, and such data as we have are based on small unit pressures. It is well known that coefficients of friction are a function of unit pressure. Hence coefficients obtained from tests under small unit pressures cannot be safely applied in cases involving large unit pressures. Yet this is precisely what engineers who design dams are doing and have done. Their factors of safety have been adequate in most instances, to protect them against erroneous coefficients of friction.

We have reason to believe that the coefficient of friction of very hard rock on its kind is greater the greater the unit pressure. But for soft rock (shale, etc.) we believe the converse may be true. We have little doubt that the coefficient of friction of clay decreases rapidly with increase unit pressure, particularly when the clay is wet. Tests should be made on a great variety of rocks and earths, dry, damp and very wet, under varying pressures up to 200 lbs. per square inch. It should be remembered that the overturning moment throws a greater pressure on the toe of a dam than that due to the weight of the superincumbent masonry. Hence the desirability of carrying the friction tests up to at least 200 lbs. per square inch pressure.

Slight jarring reduces the apparent coefficient of friction where the unit pressure is slight. Is it not likely that heavy jarring may have the same effect where unit pressures are great? If so, is it not evident that when a dam is trembling as a result of the water falling over its face, the dam may be moved by sliding more easily than when it is quiescent?

It is well known that even the slightest sliding is accompanied by a great decrease in the coefficient of friction. Hence the importance of preventing incipient sliding, entirely aside from any question as to the effect of fissuring.

A masonry dam may be perfectly safe against sliding on its base, yet the sub-base may cause failure by sliding on itself. This last is what probably happens in most cases of failure by sliding. Let there be a horizontal layer of soft shale, clay or the like, even several feet below the base of the dam, and there will be grave danger of a slipping along this plane of low frictional resistance. Hence the importance of core drilling where dams are to be founded on stratified rock, particularly where the strata are horizontal or dip downstream. The cores will show whether excavation should be carried deeper or whether a heavier dam should be designed.

Whether upward pressure or low coefficient of friction has caused dam failures is a matter of extreme importance. Those who adhere to the upward pressure theory would be satisfied with a core wall at the heel of the dam, to cut off percolation. But an engineer who regards low coefficients of friction as the cause of frequent failures would place less confidence in core walls built in rock. He would reason that capillary action would eventually result in wetting the

---

* Engineering and Contracting, Chicago.

rock sufficiently to reduce its sliding friction, in spite of the best core wall possible. He would, therefore, either increase the weight of the dam or excavate the foundation deep enough to secure a fairly deep layer of rock in front of the toe; for in the latter case he would oppose sliding not only by the weight of the dam but by the weight of a layer of natural rock below the dam.

Fig. 1 shows the difference in design that would follow the adoption of the two theories. A believer in the upward pressure theory would build the deep core wall, A, at the heel of the dam. A believer in the low friction theory would build the relatively shallow but wide wall, B, at the toe. The wall, A, would be designed merely to prevent water from flowing under the dam. The wall, B, would be designed to get a "toe hold" on the rock ledge below the dam.

This illustration will serve to indicate that the two theories must lead to radical differences in the design of masonry dams. It is highly important that tests be conducted, as above outlined, to establish to what extent each of the theories is tenable.

Cost-Keeping on Constructional Work

By G. L. Shanks

SECOND only to the ability to lead and manage men, cost-keeping is the most vital and important element in modern contracting. Granting a contractor average skill in handling men and the technical affairs of his business, his success in future contracts will usually depend on how closely his office system allows him to estimate the cost of the different elements in the work at hand. An important point to note is, that while it is often fairly easy for those in charge to study out and plan in detail a comprehensive scheme for cost-keeping on any job, it is a different matter to make the subordinates live up to the system. Most of them fail to realize the cost-analysis end, i.e., the calculation and study at certain intervals (usually every day or week) of unit costs for different items, such as mixing and placing concrete, driving piles, excavating rock, etc., and the application of these derived costs to discover and correct at once any weakness in the methods of doing the work.

The main divisions in cost-keeping on construction work are: (1)The direct charges for labor and materials, and (2) the necessary expense charges incidental to the work—often called overhead charges. These expense items, unless watched and controlled by a firm hand, are liable to total up to a large sum, and may often be the deciding factor in the financial failure or success of a contract. They include, among others:

(1) The salaries and travelling expenses of the superintending, engineering and clerical staffs on a job—also the current operating expenses of the job office.

(2) Charges for plant rental (if any), installation, maintenance, and dismantling.

(3) Building and operating a boarding camp, if there be one.

(4) Liability insurance, if any be carried.

(5) Transporting, unloading and storing construction materials—such as fuel, cement, sand, gravel or crushed stone, brick, lime, lumber and timber, piles, reinforcing steel, stone masonry, etc., etc., if the cost of these cannot be directly charged to some unit in the work, such as a pier for a bridge, or a floor for a building.

The division of the direct labor cost on a job into the different charges or sub-divisions should be done most carefully. Above all else, these charges should be practical and flexible, i.e., they should be finally decided on only after a thorough study of the actual conditions at each separate job, and they should not be so numerous as to make the system stiff or unwieldy. In short, cut the number of labor charges down to an absolute minimum, but make sure that each separate charge gives maximum service, and is sufficiently flexible so that it may be either sub-divided or expanded, if necessary. It should be constantly remembered that these cost records are kept for two main purposes: (a) As a RECORD, and for use on future work—hence they should be accurate, well arranged and easy to understand; (b) As a CURRENT CHECK on the efficiency of the work, and as a sure method of detecting any leaks or weak points in the organization or methods employed—hence they should be kept strictly up-to-date. The cost clerk or timekeeper, whose duty it is to collect and classify all this data, should have a wide practical knowledge of constructional engineering and a sound judgment, as it is sometimes necessary to differentiate carefully between various charges.

A material clerk should be held responsible for all the hand-tools and supplies on the job—his duties to include the ordering of material, the checking of the material on arrival, and the storage of same when not in use. He may sometimes include heavier items, such as heavy plant, large timbers, etc., in his work, but on large works these are usually supervised directly by the contractor himself, or by his superintendent or engineer.

There should be, as a rule, only one storehouse on a job. All hand-tools in everyday use, and all perishable supplies (except explosives, gasoline, oil, etc., which are always stored separately) ought to be kept in here under lock and key, and a careful check made of all outgoing and incoming material. Very often, in cases of emergency, supplies, tools, etc., are needed in a great hurry, and it seems hardly necessary to state that the interior design of the storehouse ought to receive careful study. The most commonly used items should be kept nearest the counter or door, and all shelves, bins, stalls, hooks, etc., should be so placed that they may be reached with the least possible motion, and the contents in or on them handled with minimum effort. These are but elementary principles to follow in order to obtain the highest efficiency, yet they are commonly disregarded.

It would be advantageous to keep two books in the storeroom: a stock book and a material charge book. The former should be a complete and up-to-date inventory of all the tools, supplies and material in use on the work, the different quantities being corrected at least daily. It may be urged that a card or loose leaf system would be just as good, if not better than a book. There is not much difference between them, the chief advantage in the use of the book being that it is more compact and affords a better chance to study and compare the variations in the use of the different items entered therein, since the stock quantity is corrected daily from the start of the job, and the amounts of the different items are all together, instead of being scattered on various individual cards which easily get misplaced.

In the material charge book all the outgoing supplies and materials (except the hand-tools, which are charged against the men using them) are charged against the different units in which they are used, such as the various piers or pedestals in a bridge, or the different floors in a building. It is not absolutely essential that entries be made in this book every day (the sooner the better, however), as the book is not usually needed until the structure is finished. Then, indeed, it is valuable.

The supply of iron rods, bars, flats, tool steel, etc., used by the blacksmith is, of course, kept by itself close to the smithy, and all that seems to be necessary with this item is to enter in the stock book every time a new supply is received, so that the working capital, as it were, is known at any time. It seems to be unnecessary to book up from day to day the comparatively small amounts used up, as the blacksmith can always be consulted as to the standing of any single item, and as to when any new supply is needed. He reports to the material clerk, each day, the quantity used and what units it is to be charged against.

With regard to pipe-fittings of all sizes, valves, etc., it would seem to be better to correct the stock book from day to day, so that a close check can be kept on the stock, and needed material ordered ahead of time—the lack of these small fittings, at critical times, often causing serious inconvenience and delay. All outgoing material is to be charged to the different charge heads as before.

Supplies in current use, such as nails, belts, spikes, washers, rope, oil, etc., should be booked up and charged out as closely as seems practicable and reasonable. Naturally, the standard of refinement on other portions of the work will govern the standard of the office work in the storeroom. For example, it would not pay to be severely economical in the use of nails, as the carpenters might thereby be induced to turn out inferior work, and yet, on the contrary, money may be literally thrown away if some vigilance were not exercised over the nail supply. The oil question is another one which might be discussed in the same way. There is a happy medium which can be reached in all these things, and although it is sometimes rather hard to educate the employees to appreciate the economical ideals of the management, it is possible, and is certainly a goal to be aimed at.

Hand-tools, rain-coats, rubber boots (if supplied at all) and similar articles which are used and kept by the men, personally, ought to be handled somewhat differently. In the stock book should be kept a list of the total stock received from time to time and supposed to be on hand. It does not seem necessary to correct the stock book any further, because all the outgoing boots, coats, tools, etc., will be charged up to the different men personally. A loose sheet or notebook may be kept to enter up daily the hand-tools, such as hammers, wrenches, peavies, crosscut saws, etc., which are taken out early in the day, or at various times during the day, and brought back in the evening. All hand-tools should be returned the same day they are taken out of the storeroom, and any not returned ought to be charged against the man taking them out.

Tunnel Construction and Ventilation for Railroads

After a general consideration for several years of the subject of tunnel construction and ventilation, the committee on roadway of the American Railway Engineering Association has reached conclusions, which have been adopted, as follows:

1. Railway tunnels, as ordinarily constructed in the United States, are more economically built by first driving the heading entirely through, but such method usually requires a greater length of time for completion of the tunnel.

2. For material requiring support the top heading should usually be driven.

3. It is economical and expedient to use an electric shovel or an air shovel for the removal of the bench where the section of the tunnel permits its safe operation; and where the material does not require support there are advantages in low cost and quick removal of the bench in driving the heading at the subgrade line.

4. Where the time limit is of value, the heading and bench should be excavated at the same time, the heading being kept about 50 ft. in advance of the bench. Where the material of roof is not self-supporting and timbering is to be resorted to, the bench should not be removed until the wall plates are laid and the arch ribs or centering safely put up.

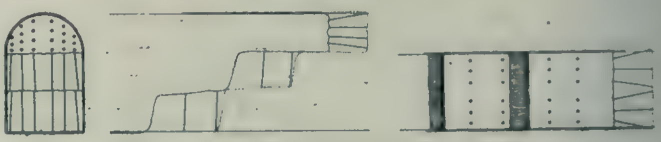


Fig. 1—V Cut for Use in Hard Rock with Few Seams

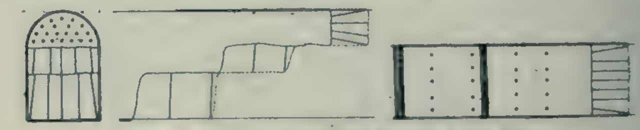


Fig. 2—Hammer Cut for Fairly Hard Rock with Seams

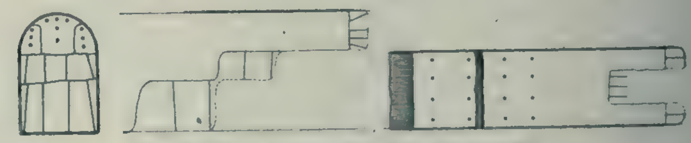


Fig. 3—Method Applicable to Soft Rock or Hard Clay

5. Opposing grades should preferably not meet between the tunnel portals so as to put a summit in the tunnel. Where practicable, the alignment and ascending grades in the tunnel should be in the same direction as the prevailing winds.

6. The accompanying drawings are representative of American practice in single-track tunnel construction, where the time limit is of value.

Explanation of Figures

The typical method in hard rock with few seams is shown in Fig. 1. The heading in material of this kind is usually driven by a V cut, using from sixteen to twenty-two holes about 8 ft. deep. The holes near the middle of the heading are drilled so as nearly to meet at the end. These holes are shot first, then the second row and lastly the outside holes. The arrangement of these holes will vary slightly, according to the way the material breaks.

The bench in material of this kind is usually taken out in two lifts of almost equal weight. The sub-bench is drilled from 20 to 40 ft. in advance of the bench.

From four to eight holes in a row, with 6 or 8 ft. face, are used in both sub-bench and bench. One or two rows of holes may be used. The center holes are shot first and the side holes last.

For moderately hard rock with seams the method outlined in Fig. 2 is employed. The heading is usually driven by a "hammer" cut, using from fourteen to twenty holes 6 to 10 ft. deep. The bottom row of holes is inclined at an angle of about 30 deg. The rows are shot in succession, beginning at the bottom. The holes should be arranged to suit the seams in the material.

The bench is sometimes taken out in one lift, but usually in two, with the sub-bench not as deep as the bench. The sub-bench is best drilled from 20 to 40 ft. in advance of the bench. From four to six holes in a row may be used with from 6 to 10-ft. face. The center holes are shot first and the side holes later.

The method indicated in Fig. 3 is used only when the material is so soft that the heading cannot be driven for the full length of timber used for the wall plates. Drifts about 4 ft. wide and 6 ft. high are driven for each wall plate, and the core is taken out as the timber rings are put in. Three or four holes from 3 to 5 ft. deep may be used in each drift. The amount of shooting necessary depends entirely upon the softness of the material, which can often be picked. The core may be soft enough to pick, or may be shot with from four to eight holes, drilled either from the face as shown or from the sides of the drifts.

In this class of material the bench is shot in one or two lifts. Only a few holes are necessary.

Tunnel Ventilation

Most practicable, effective and economical artificial ventilation for tunnels carrying steam-power traffic is to be obtained by blowing a current of air into one end of the tunnel for the purpose of removing, or of diluting and removing the smoke and combustion gases at the opposite end. As practised in America, this way of procuring ventilation partakes of two methods:

1. To blow a current of air in the direction the train is moving and with sufficient velocity to remove the smoke and combustion gases ahead of the engine.

2. To blow a current of air against the direction of the train with velocity and volume sufficient to dilute the smoke and combustion gases to such an extent as not to be uncomfortable to the operating crews and to clear the tunnel entirely within the minimum time limit for following trains.

The Administration of Municipal Public Works, Especially Relating to Highways*

By Nelson P. Lewis†

MOST American cities have a department of public works. The organization of such a department and the precise field covered by it vary in almost every city. Generally such a department has control over the preparation of city maps; street surface improvements, including grading, paving, sidewalks, maintenance, repairs and renewals; street signs and house numbers; sewers and sewage treatment; water supply and distribution, including the care of watershed, filtration, etc.; street cleaning, including the collection and disposal of wastes; street lighting; public buildings, the construction and reconstruction of surface railway tracks in streets; and the elimination of railroad grade crossings.

In cities of moderate size, say 300,000 or less, this work is usually under the more or less complete control of the city engineer, although there are conspicuous exceptions. In very large cities the organization is more complex, sometimes jurisdiction over but one or several of these activities being under a single administrative head; again, a larger group or all are under one head, but under a number of different administrative units, each with limited geographical jurisdiction. An example of the first-class is the organization provided by the first Greater New York Charter, under which commissioners of water supply, sewers, street cleaning, bridges, public buildings, lighting and supplies each had jurisdiction over the entire city, and together they formed the board of public improvements, the president of which, a separate officer appointed like the others, by the mayor, had control over all topographical work. This was the charter which took effect immediately after the Consolidation Act, which created the Greater City. Everything was new. No definite policies had been established, and the results were generally unsatisfactory, although a conclusion that these results were due to the organization, instead of the chaotic condition which resulted from the consolidation into one city of a score or more of cities and villages, might not be justified.

An example of the second class is that of Greater London, where there are thirty separate administrative units, which are practically independent cities, each administering its own local affairs and raising the money which they feel they can afford to spend on the street and other services. The City of London comprises 673 acres and has less than 20,000 population. Even here, however, the London County Council has jurisdiction over certain municipal functions which are essentially metropolitan, such as the water supply, the main drainage system, the surface railway lines traversing two or more boroughs, and certain street improvements which extend beyond the limits of a single borough and which are of great importance to the entire metropolitan district.

In the present City of New York is found a combination of these two general plans. The head of each of the five boroughs has entire control of the mapping of its territory, the improvement of its streets, including the maintenance and renewal of pavements, the design, construction and maintenance of sewers, including sewage treatment plants, and of all public buildings and offices, and in two of the boroughs of street cleaning and the disposal of wastes. Other functions which necessarily relate to the entire city and where local jurisdiction would be unsatisfactory are under the control of department heads appointed by the Mayor, and they have jurisdiction over the entire city. The chief borough officers, to-

---

[*] Abstract of lecture delivered by Nelson P. Lewis before the Graduate Students in Highway Engineering at Columbia University.

[†] Chief Engineer, Board of Estimate and Apportionment, New York City.

gether with the Mayor, the Comptroller and the President of the legislative body, form the Board of Estimate and Apportionment, which body has a pretty general control over all city activities, so that the City of New York comes nearer having a commission form of government than is generally realized. There always have been and there still are in the City of New York a number of special commissions. The Brooklyn Bridge was built and operated by such a commission when it was an inter-city bridge. The new East River Bridge, now known as the Williamsburg Bridge, was also built by a separate commission. Brooklyn has had the Atlantic Avenue Improvement Commission, the Shore Road Commission, and the Brooklyn Grade Crossing Commission, while the Greater City has the Metropolitan Sewerage Commission, the Board of Water Supply—having control of the development of the Catskill Watershed—and the Public Service Commission for the First District. This last-named Commission is a peculiar one. It was created by the State, and its members are appointed by the Governor, the city authorities having no voice in their selection, and while the salaries of the Commission and a few of the administrative staff are paid by the State, the expenses of the vast majority of the staff, amounting at the present time to nearly $2,000,000 annually, are paid by the city, and the chief function of the Commission is to spend money raised exclusively by the City of New York without any contribution whatever from the State, which created the Commission. Certain public or semi-public activities are carried on by organizations having no official connection with the city, but which are allotted certain funds for enterprises which would otherwise doubtless be conducted directly by the city. Among such bodies are the Trustees of the Metropolitan Museum of Art, the Trustees of the Museum of Natural History, the Brooklyn Institute of Arts and Sciences, the Trustees of the Public Library and its great number of branches, the New York Zoological Society, which maintains the Zoological Garden in a portion of Bronx Park, and the New York Botanical Society, which has the care and custody of the remainder of the same park. No enumeration of special bodies whose influence has been potent in varying degree would be complete without naming the Bureau of Municipal Research, the Citizens' Union, the City Club, and a host of civic organizations, representatives of which give the city officials the benefit of their advice on almost every subject, but none of which exercises such influence and actual power as do the three first named. None of these organizations has any responsibility to the people of the city.

New York is not alone in working through special commissions. Chicago's park system is managed through a separate commission for each park, and the results appear to have been most satisfactory. The City of Baltimore has lately established a Paving Commission, entirely distinct from the Department of Public Works or the City Engineer's office.

Then, there are the various forms of commission government, the commission in each city which has adopted this system having much latitude and the details consequently varying greatly. Perhaps the best and most efficient form of administration is that to be found in cities of moderate size, where one administrative head and the city engineer have virtually entire control. There is one serious defect which is the more pronounced in the smaller cities, and that is the practice, if not the right, of citizens to dictate to a certain degree what kind of improvements are to be made and their character. The town meeting method will answer very well for the village or the very small city, but as the city grows, as its organization becomes more complex, there is more and more need for technical skill in the planning and execution of its public works, and as the city grows the general interests of the community and the particular interest of the property owner are likely to grow more and more apart. In the small town the individual and the property he represents form a much greater relative part of the population and of the physical city than is the case in the larger city. There is no field of municipal work where the engineer has the opportunity to develop greater versatility than in the moderate sized city, corresponding, say, with cities of the second class in New York State. Here the city engineer, appointed by the mayor, is a voting member both of the board of estimate and apportionment and of the board of contract and supply. He is called upon to exercise control over almost every kind of public work incidental to the modern city. The work may not be of the magnitude to be found in the greater cities, but its variety is far greater than that which comes to the engineer of cities of the first class, where jurisdiction and responsibility are sub-divided. Having less of a certain kind of work to do, he takes it very seriously and it is often exceptionally well done. The practice of electing a city engineer by the council or other legislative body, or, as is done in some cases, by popular vote, cannot be too strongly condemned. Past experience has given good ground for the general statement that no man should be selected to do professional or highly technical work by election, whether that election be by the general public or by a legislative body. Those who are called upon to vote for candidates for such an office have no means of knowing their peculiar qualifications or lack of qualifications, and better results will almost invariably be obtained if responsibility for the appointment of a man to do much work is vested in the chief executive of the city.

One of the most fertile sources of inefficient administration and of unsatisfactory results is a divided responsibility. In the City of New York the President of each borough is responsible for the care and condition of the public streets, and yet the Department of Water Supply, the Fire Department or the State-created Public Service Commission has the right to open the pavement for the purpose of installing the underground structures without the consent, and often without the knowledge, of the officer who is held responsible for the condition of the streets. The surface railway companies must secure permission from the Borough President to open streets, but gas companies, electric light companies and telephone companies must also get permits from the Department of Water Supply, Gas and Electricity. In all these cases we have a dual responsibility which is inimical to proper control. An amusing instance of the lack of knowledge in one city department of what exists in city streets under the control of another department was afforded the speaker several years ago in the City of London. Application was made to the authorities of the City of Westminster for the right to examine pipe galleries in Charing Cross Road and Shaftesbury Avenue. There was apparently no knowledge of the existence of such pipe subways, and after extended inquiry the speaker was told that there was no subway large enough for a man to enter. Upon application next day to the Chief Engineer of the London County Council, a member of the Engineer's staff was immediately delegated to conduct the speaker through capacious pipe galleries in these two streets, while the Westminster authorities did not seem to be aware of their existence.

The following requisites are necessary in order to secure satisfactory results in highway administration.

1. Centralization of authority over and responsibility for all work to highways within the administrative district.

2. Such flexibility of organization as will permit a concentration of force on any work of pressing importance.

3. Administrative units sufficiently large to permit the utilization of an entire force and equipment all of the time, reducing overhead charges to a minimum consistent with efficiency and thoroughness.

4. Get rid of the prevalent horror of a bureaucracy. If such a bureaucracy works well, it is a good thing. If it works badly, it is not because it is a bureaucracy, but because it is not well organized.

5. Direct and undivided responsibility for every part of the work, each head of a bureau or sub-division to be made to realize, however, that his own particular work should be so done as to help and not to hinder that of other bureaus or divisions.

6. Promotion to the headship of bureaus and departments to be made from within the organization when possible, not necessarily according to seniority, but by reason of peculiar fitness. When it is necessary to go outside of the organization to fill such a place, the appointee should be one who has already made good in similar work in some other place.

7. Permanent tenure of office for those in responsible charge, so that continuity of purpose and policy may be assured.

Construction Plant and Methods Employed in Placing the Cofferdam for the New Intake Tower of the St. Louis Water-Works*

THERE is now under construction at St. Louis a new water works intake tower located in the Mississippi River, near the Illinois shore, and a 2,789-ft. tunnel leading from the tower to a screen chamber at the present pumping station at the Chain of Rocks on the Missouri shore.

The contract for the screen chamber, tunnel and intake tower was awarded in the spring of 1913 and work was started about July 20.

The difficulties of unwatering the site for the intake tower were great as it is located in from 18 to 22 ft. of water, at normal river stages, on a rock bottom which is very uneven, and in a current of 3½ to 4 miles per hour. Added to this is the fact that the river is subject to sudden and heavy rises and in winter is filled with floating ice which frequently and suddenly jams at various points and as suddenly lets go again.

The various methods of unwatering cofferdams were considered, most of them being discarded as unsuitable. Finally the method of constructing an annular caisson large enough to enclose the entire tower with several feet to spare was adopted.

The caisson is built of squared yellow pine timber, contains, altogether, 200,000 ft. b.m. of timber. It is 94 ft. long and 52 ft. wide over all, giving a space 78 x 36 ft. inside. This allows about 4 ft. space on all sides between tower and cofferdam. The caisson was partly built on four barges and was towed about 8 miles up the river from St. Louis to the site of the tower and was there completed. The caisson is shown in part plan in Fig. 1 and in vertical section in Fig. 2.

Construction work was commenced July 26, 1913, on the barges for floating the caisson and they were launched at the rate of one a week thereafter until the four had been completed. These barges were 48 x 20 ft. in plan and 5 ft. 2 ins. deep. The bow was built with a rake end or overhang of 6 ft. and the stern was square. They had one bulkhead running fore and aft in the centre. The gunwales were of 4 in. x 12 in. planks outgaged to form a caulking seam. The bulkhead was also of 4 in. x 12 in. plank without the caulking seam. The bulkhead was in the centre of the barge and halfway between it and the sides were two streamer planks thoroughly braced and tied to the cross frames. The decks were of 2 in. planks outgaged and caulked. Altogether this construction made very stiff barges and strength was requisite as they were required to withstand hard usage. Vertical sections through the barges are shown in Fig. 3 and detail of end and cross frames in Fig. 4.

When all four barges were in the water, launchways of 8 in. x 12 in. timber were laid athwartships on their decks. A sketch of the launchways is shown in Fig. 5a. These timbers were laid flatwise and reached entirely across the barges. The tops of the launchways were greased with tallow and butterboards of 4 in x 12 in. planks with lugs to keep them from slipping laterally were laid on top of the launchways. Then the barges were spaced the proper distances apart and held in position by 12 in. x 12 in. timbers bolted to the timber heads and stiffened by diagonal braces of 2 in. plank spiked to the decks of the barges and to the tie timbers.

The cutting edge of the caisson was laid down on the butterboards and both walls were carried up to the deck. The deck was then placed and the walls were carried up to four courses above it, before the caisson was towed to its final location. Figure 6 shows spacing of barges and location of caisson and the method of bracing barges apart.

The problem of anchoring the caisson was rather complicated in the swift current. Upstream the bottom was rock with pockets of sand; on the west side it was the same and on the east side it was loose river sand. The best way to provide anchorage was to drill holes in the rock of the river bottom and let in ring bolts for the upstream and the west anchors and to use concrete blocks for the east anchor.

It was too expensive to equip a boat with spuds in order to hold it steady to drill from and it was also out of the question to drill from a raft or floating boat as the current and wind would swing it from side to side in spite of anchors, while waves from passing boats would cause it to rise and fall from 2 to 3 ft. Therefore a drill platform to rest on the river bottom was constructed. The details of this platform are shown in Fig. 7. It was composed of a concrete block with a section of 12-in. pipe imbedded in it and a timber platform fastened to the top of the pipe. The concrete block was 6 ft. square and 3 ft. thick, the pipe being imbedded in it for 2 ft. The pipe was 22 ft. long and as the bottom was 1 ft. above the bottom of the block this brought the top of the pipe 23 ft. above the river bottom when it rested on the bottom. It was braced to the concrete block by means of eight 1-in. reinforcing bars, the lower ends of which were cast in the block near its outer edges and the upper ends of which were clamped to the pipe by a heavy collar at a point about 4 ft. above the block. On top of the pipe was a standard flange and below it were two 6 in. x 8 in. timbers 6 ft. long running parallel to each other and at opposite sides of the pipe. These timbers were bolted together and bolts running down through the flange kept them from slipping down. Across the top of the 6 x 8's and spiked to them were laid 3-in. planks 6 ft. long the whole forming a platform 6 ft. square. Holes were left through the platform alongside the pipe to allow a chain to be passed around the pipe and up through platform to admit of the whole being lifted with a derrick. From the pipe directly under the platform a ladder ran down to the concrete block and was fastened securely to both pipe and block.

---

*Abstract of article by C. H. Hollingsworth, in Engineering and Contracting.

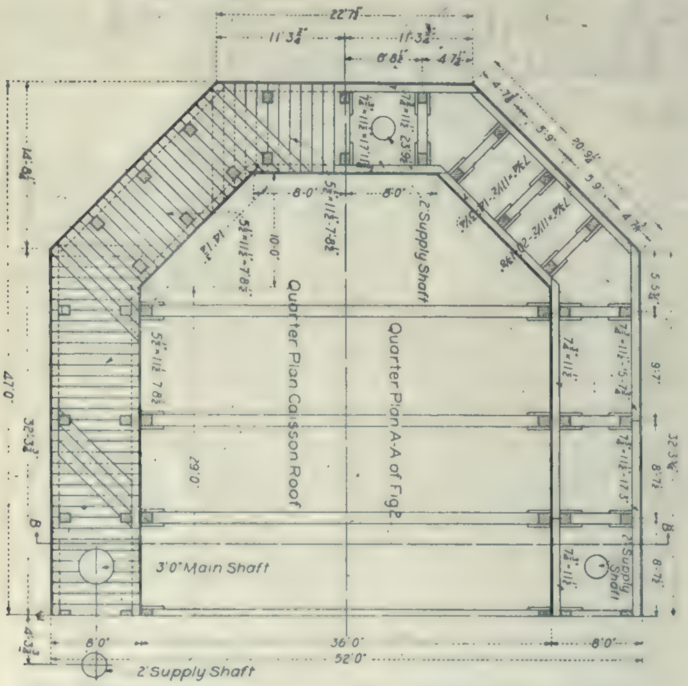


Fig. 1—Quarter plans of caisson employed in constructing new intake tower of St. Louis water-works at roof and below deck.

When this platform had been assembled it was handled by a tower derrick mounted on a 30 ft. x 60 ft. barge. This derrick was intended for use in setting stone, steel, etc., on the intake tower itself. The timber tower was 30 ft. square and was set 32 ft. above the deck of the barge. It was built of 12 x 12 in. and 12 x 16 in. timbers and strongly braced. On top of this tower a combined A-frame and stiff leg derrick was erected with a 32-ft. mast and a 50-ft. boom. As the tower and derrick were set back about 12 ft. from the bow of the barge there was plenty of room in which to place the drill platform when not in use or when changing from one hole to another. The holes for the upstream anchors were drilled first and to drill them the derrick boat was anchored with the stern up stream by means of two lines running to two concrete anchor blocks previously placed. The barge was then directed into position north and south by the engineers from a base line previously established and set on position east and west by means of an instrument and a stadia rod. The barge was moved east or west until the rod reading checked with the distance which had been worked out by triangulation. Figure 8 shows a plan of the derrick barge and the method of anchoring it and the drill platform while drilling holes for anchor bolts.

The drill platform was lifted by the derrick and lowered until the concrete block rested on the river bottom. In spite of the weight of the block and platform (about 16,000 lbs.) the current would sweep it down stream a considerable distance and spin it around. To prevent this lines had to be made fast to the foot block to keep it from drifting and other lines were made fast to the ends of 2 x 4-in. pieces spiked along the sides of the platform to prevent it from spinning. When the concrete block rested firmly on the river bottom and the derrick had been unhooked, the drill, an Ingersoll D-24 machine, was set up on the platform and the drilling started. The hole in each case was started with a 24-ft. steel and when this had been run out it was followed by a 26-ft. steel. The first steel measured 3½ ins. across the bit while the second measured 3¼ ins. The length of the bolt to be inserted in the hole was then carefully measured and the hole was drilled accordingly. The depth averaged about 4 ft. and it was about 3¼ ins. in diameter at the bottom. After the drilling of the hole the ring bolt was lowered down carefully through the 12-in. pipe by means of a ½-in. cable attached to the ring. These bolts were split at the bottom and a wedge was inserted in this slot. A detail of the 3-in. anchor bolts is shown in Fig. 5b. The drill hole would break out around the top leaving a cone shaped hole about 8 ins. across the top and tapering to the regular diameter of the hole at about 10 in. below the surface of the rock. This made the entering of the bolt in the hole a comparatively easy matter except that it had to be done very quickly else the fine sand carried by the river water would fill the hole in a few minutes. After losing one hole that way, however, matters were arranged so that no time was lost in getting the bolt into the hole as soon as possible after the hole had been drilled. The drill was hoisted off the platform by the derrick which also placed the ring bolt. A piece of steel shafting 6 ins. in diameter and 12 ft. long was swung on a single or runner line from the derrick boom and after care had been taken that the ring was swung over to one side of the pipe the ram was lowered until it rested on top of the eye. It was then lifted a few feet and dropped repeatedly, driving the bolt down firmly to the bottom of the hole and forcing the wedge up into the slot and expanding the sides of the bolt tightly against the sides of the hole. In this way all bolts were set down firmly into the holes with their eyes hard against the rock of the river bottom. When the bolt had been driven home the derrick was hooked to the platform and the latter raised high enough to clear the ring of the bolt and the lines leading to the foot block were slacked enough to allow the current to drift the platform down stream a few feet when it was lowered again clear of the ring bolt and downstream from it. The diver then went down the ladder which was always kept on the upstream side of the platform and found the bolt by the simple method of getting hold of the ½-in. cable leading down through the pipe to the ring and following it to the ring. The end of this cable had previously been made fast on the barge and was left attached to the ring bolt for use as a buoy line. When the diver had located the ring bolt the end of the anchor cable was sent down to him by a hand line. This cable was attached to the anchor bolt by means of a 1½-in. shackle for the upstream anchors and a 1-in. shackle for the side anchors. A detail of the plate and shackle for fastening the upstream anchor cables to the side of the caisson is shown in Fig. 5c. When the cable had been shackled on the drill platform was lifted clear of the water, the bight of the ½-in. buoy cable caught below the bottom of the pipe, the end was allowed to run through, a buoy was made fast to it and thrown overboard and the anchor cable, which in the case of the upstream anchors was 1-in. steel cable, was coiled down on the deck of the barge.

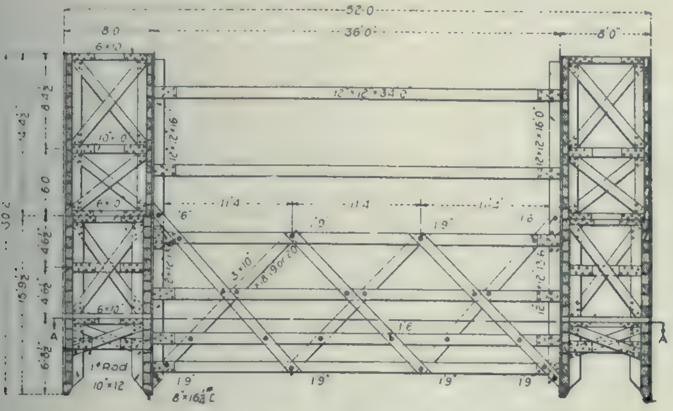


Fig. 2—Vertical section B-B of Fig. 1, caisson for St. Louis intake tower.

When the four upstream anchors had been set the caisson was towed up to position. As the steamboat pushed the caisson ahead of it, it was an easy matter to work it carefully up to the downstream end of the derrick barge, take the four anchor cables aboard, make them fast and drop back until the cables were taut. After the caisson had been anchored from these cables the side anchors were placed. The west side anchor bolts were placed as already described except that the ring bolts were 2-in. instead of 3-in. Then the anchor cables, which in this case were composed of two parts of ⅝-in. steel cable for each anchor, were taken aboard the caisson and made fast.

The east side anchors as previously stated, consisted of three concrete blocks for each anchor. These blocks were 6 ft. square and 2 ft. thick. In the tops of the blocks were two loops of 1-in. round iron for use in handling the blocks and in the side of each one was a loop of 1½-in. iron for attaching the anchor cables. The bottoms of the blocks were studded with pieces of 1½-in. square iron 18 ins. long. About 12 ins. of the length was imbedded in the concrete and the remaining 6 ins. projected so that they would catch in the inequalities of the rock in case the block settled down in the sand low enough for them to reach the former. A loop consisting of four parts of ⅝-in. steel cable and about 4 ft. long was passed through the 1½-in. iron loop in each block and a piece of 1-in. steel cable about 60 ft. long run through these short cables and clipped in a loop 30 ft. long. This was to allow of flexibility enough to enable each block to bear part of the strain and to allow them to settle to a solid bearing without in any way interfering with each other. The 1-in. cable loop was long enough so that when pulled straight upwards by a derrick barge the clips on it would be above water and so allow their removal. From each set of blocks the anchor cables were run to the caisson and made fast.

The three blocks for one anchor were placed simultaneously by setting them on edge along the front edge of the derrick barge with the bottoms facing outward and with an 8-in. x 8-in. timber held up against the 1-in. loops in their tops by the main fall of the derrick on which a light strain was kept. The steamboat pushed the barge up stream until the right location had been reached when a heavy strain was taken on the main fall and the three blocks were all dumped overboard at the same time, after which the cables were taken aboard the caisson.

Launching the Caisson

When the caisson had been built up to a point about 16 ft. above the cutting edge, sheathed and caulked, preparations were made to launch it. The timber heads coming inside the caisson were cut off flush with the decks of the barges and all bracing between barges was removed. In each of the four barges a 2-in. stop cock was placed about 2 ft. below the deck and in the sides which were turned inward. A 2-in. hole was also bored in the bottom of each of the barges directly under the hatch and plugged. A derrick barge was moored at each side of the caisson and about 75 ft. distant from it. They were held upstream by a ⅝-in. steel cable made fast to one of the upstream caisson anchors and one part of the ⅝-in. cable from each of the side anchors on that side was carried aboard the barge and made fast. Then a set of double blocks rove with 1½-in. manilla line was hooked to each of the barges under that side of the caisson and made fast aboard the derrick barge while the hauling part of this was led through snatch blocks to the hoisting engine.

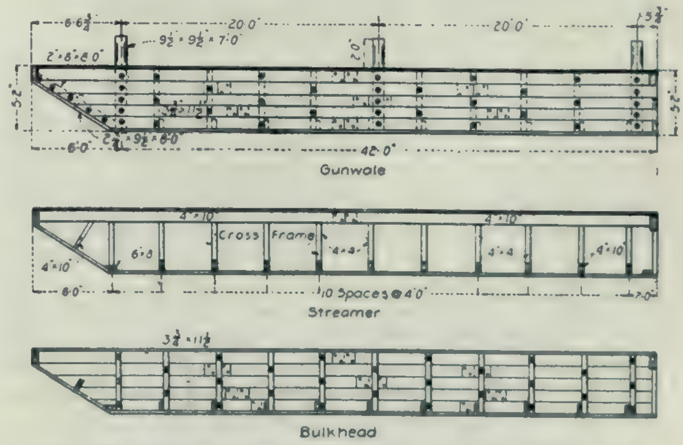
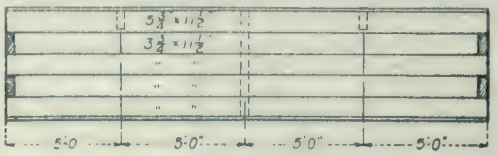
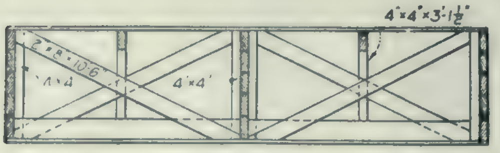


Fig. 3—Vertical sections through gunwales, streamers and bulkheads of barges for floating cofferdam caisson into place, St. Louis intake tower construction.

When both sides were made ready in this way the lines were pulled tight on all four barges and a slight strain put on each. The stop cocks on the barges were then opened and the plugs taken from the bottom holes allowing them to sink slowly. All four barges settled at a very even rate until the decks were awash when the upstream ones settled more rapidly than the others owing to the current carrying them under. When the decks of all four barges were under water as much strain was taken on the hauling lines as the manilla rope would stand. The filling of the barges began at 4.30 p.m., October 2, and at 7 p.m. the decks were under water. A few minutes after that the buoyancy of the timber in the caisson began to lighten the load on the barges and about 7.13 p.m. three of them slid out and bobbed up to the surface like corks. The fourth barge which was the downstream one on the east side, slid out part way and then stuck. At that corner the rock was very high in the bottom and the caisson when floating came within about 3 ft. of the bottom. As the barge was 5 ft. 2 ins. high it became jammed between the crib and the bottom when all but one corner had slid free. The other barges were all caught by the steamboat and taken ashore to be pumped out. Next morning after the slack had all been taken out of the anchor cables opposite to the refractory barge, the latter was easily pumped free and the caisson floated, drawing about 14 ft. of water which was slightly more than calculated upon. Some parts of it were not caulked up to the water surface and it was rolled first to one side and then the other and the caulking carried practically to the top before any additional timber was added. This was accomplished by placing a gin pole in each corner on the same side with their bottoms resting on the river bottom and a set of blocks leading from their tops to the top of the crib. Lines from these blocks were then led to a hoisting engine and a strain taken. This, aided by the buoyancy of the crib itself, elevated that side of the crib from 3 to 4 ft. allowing the caulking to be done, after which that side was allowed to settle down and the gin poles shifted to the other side and it was handled the same way. The construction on the caisson was then resumed and the timber carried up to about 26 ft. above the cutting edge at which time it rested firmly on bottom all around.



End



Cross Frame

Fig. 4—Detail of end and cross frame of barges shown in Fig. 3.

The rock bottom, as before stated, was extremely uneven and the south-east corner was 3 ft. higher than the northeast corner giving the caissons a very bad twist. Also there were depressions in the bottom where the cutting edge would be from 2 to 3 ft. clear of the bottom. When the caisson had been completed up to a point 26 ft. above the cutting edge or to about elevation 89 an attempt was made to put air on it but as the only compressor on hand was one of 675 cu. ft. per minute capacity and as the twisting of the caisson had caused the seams to open up, no headway was made as the air leaked out about as fast as the compressor could pump it in. Clay filling was then dumped in the space between the walls, on top of the deck which was a departure from the original scheme which was to fill this space with sand as ballast. The clay, however, acted as ballast and in addition helped materially to stop the leaks.

When about 10 ft. of clay had been dumped in another attempt was made to put the caisson under air. While 2 or 3 lbs. of air would be registered on the gage it was still impossible to get it through the main lock which unfortunately happened to be located on the low side of the caisson. When the air had reached about 2 lbs. pressure it had forced the water down so low in the working chamber that numerous leaks were exposed and at the same time the water was not low enough to admit men through the main lock at the low side. It was decided to cut through the deck at the highest corner and place a new man lock there. In order to do this the pocket at the high point was cleaned out and pumped dry and a section of main shaft set down on the deck. Concrete was then filled in around it and allowed to set. A lock door had been placed in position at the top of the shaft section and when the concrete had sufficiently set, air from a small compressor was introduced through the 1-in. blowoff valve in the door, after two men had gone inside. The air pressure was kept at about 6 lbs. while the men inside fastened the shaft section down to the deck with 1-in. lag screws running through the flange on the bottom of it through which were 24 holes. Then a small section of the deck was cut out to allow a man to pass inside. The air was then taken off this shaft section and a second section bolted to the top to form a man lock.

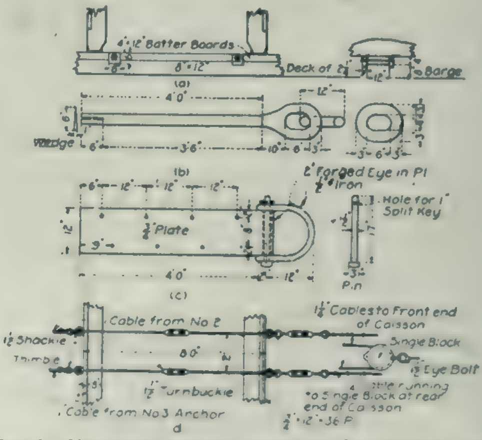


Fig. 5—Details of launching ways and anchorages for cofferdam caisson, St. Louis water intake tower construction.

One disadvantage in the concreting operations was that it was impossible to expose the rock at all points for in order to do that the air pressure would have had to be raised so high that it would have blown out under the cutting edge as much of the bottom was from 1 to 5 ft. below the latter. As the water was muddy the state of the bottom had to be determined by feeling with an iron bar, to see whether or not it had been sufficiently cleaned. When the concreting was going on the pumps were being set up to pump out inside the crib. These included a No. 6 direct connected centrifugal pump with a capacity of about 1,000 gals. per minute, one belt driven No. 5 centrifugal pump with a capacity of about 800 gals. per minute and two 6-in. steam siphons with a combined capacity of about 2,500 gals. per minute.

Unwatering Operations

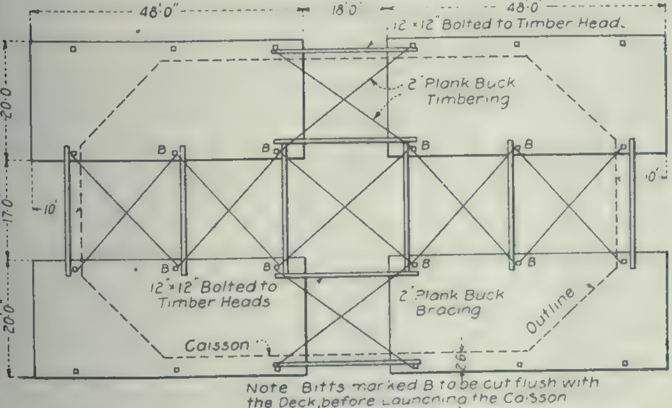
When the caisson had been sealed down to the rock air was still kept on it and the pumps were started. They lowered the water level inside the crib to a point about 5 ft. below the river level after which it came back to its former level, showing that as soon as any head was put on from the outside a large leak had started. A sand dredge with a 15-in. centrifugal pump on it was obtained temporarily to see if the water could not be pumped down so we could get at the leak. This pump was rated at about 6,000 gals. per minute capacity. The dredge was tied up alongside the caisson and the suction dropped inside the latter. When this was in position it and all the other pumps were started and again the water was pumped down about 7 ft. and then it started to rise again. The pumps were kept going and a diver sent down to find out just where the leaks were.

His examination showed that the greater part of the leakage was from the west or low side of the caisson.

The pumps were again stopped and men were sent inside the working chamber to cut down through the concrete at the points where the water came through under it. This was a slow job as there was very little room to work and the concrete had set very hard. At first a hole about 2 ft. square was cut through the concrete in each of the pockets along the west side and when it was found that there was a cavity under the concrete these holes were connected by a slot about 18 ins. wide. Numerous cavities were found with boulders in them and at other places quantities of loose gravel would be found. In the former case there had been hard gravel in the holes with boulders wedged tightly together on top and to anyone sounding the bottom with an iron bar the boulders would appear the same as the solid rock. When the pressure come from the outside, however, the small gravel and sand washed out leaving the boulders in the hole.

When the loose gravel and boulders had been cleaned out the holes under the concrete were filled with a rich mixture of concrete except directly under the slot that had been cut along the center of the working chamber. From the rock up to the top of the concrete this slot was filled with neat cement making a cut off wall and the cement set up quickly. Where it was found that the concrete had been bonded firmly to the rock upon cutting the 2-ft. hole first referred to nothing was done except to refill the hole with neat cement mortar. When this had set, the pumps were again started but meantime the entire pumping plant had been changed. The 15-in. sand dredge had been taken away, and as the two 6-in. syphons used a great amount of steam for the amount of water pumped and as the rest of the plant was entirely inadequate to cope with the situation a direct connected 12-in. Morris centrifugal pump was obtained with a capacity of 4,200 gals. per minute. In addition a 5-in. Emerson and an 8-in. Emerson pump were installed having a combined capacity of about 4,500 gals. per minute.

In starting to pump out, however, only the 12-in. and the 5-in. centrifugal pumps were used and these pumped the water down so that the bottom was exposed in about two hours. The bottom was first cleaned of silt of which there was a deposit about 3 ft. deep and then the sand and gravel was excavated. There seemed to be some very extensive leaks after the sand and gravel had been removed as the pumps continued to handle 2,500 to 3,500 gals. per minute according to the stage of the water in the river. The leakage came in chiefly in the northwest corner and midway along the west side. This leak when uncovered proved to be a horizontal seam which came to the surface about 10 ft. inside the cofferdam and dipped rapidly so that it must have been about 4 ft. below the surface under the center of the working chamber. From this seam a vertical seam led downward about 10 ft. being 6 to 8 ins. wide. These seams could not be caulked so a bulkhead of 2-in. plank and timbers was built across the corner, grout pipes were inserted in the seams with the tops of same above water level and then the space inside the bulkhead was filled with clay and grout was forced into the pipes stopping the greater part of the leakage from that source.



Note Bitts marked B to be cut flush with the Deck, before Launching the Caisson

Fig. 6—Plan showing spacing of barge and location of caisson on same—also method of bracing barges apart.

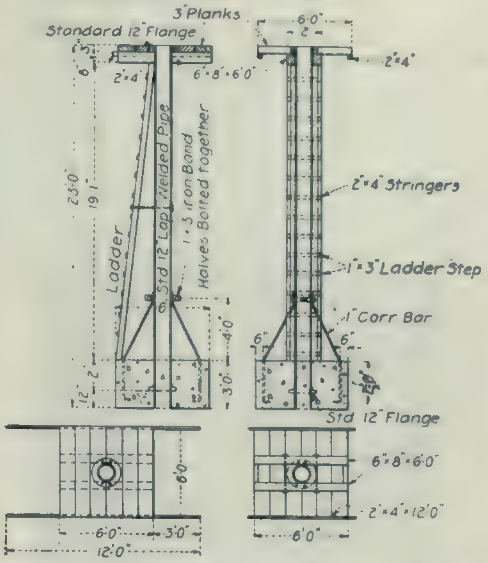


Fig. 7—Details of portable platform for drilling holes for anchor bolts on river bottom.

As the bottom rock was cleaned off, however, and the surface rock pried loose other leaks developed and incidentally the cause of the difficulty in getting the caisson sealed tightly to rock became apparent. In the rock which was a fine grained hard limestone, there were holes and watercourses worn which were tightly packed with gravel and sand and with small flat boulders wedged tightly on top.

When it was found that the pumps would handle the water without trouble the air was taken off the caisson, and the working chamber allowed to fill with water. Also the timber of the crib walls was carried to about elevation 92 and levelled up. The average water level at ordinary stages is about elevation 82. The space on top of the deck and between the walls of the caisson was filled with sand up to a point 1 ft. below the top excepting the upstream end where the filling was only carried up about 10 ft. above the deck and the remainder of the filling was done with concrete. One foot of concrete was also placed on top of the filling all the way around the caisson, bringing it up flush with the tops of the timbers. The sand filling was to give the crib weight and the concrete in the upstream end was to help withstand the blows and shocks from floating ice, while the concrete finish on top of the sand filling was to prevent the water from washing out the sand when it was high enough to run over the top of the crib. Timber heads were bolted to the upright timbers and left projecting above the concrete finish and eye bolts were placed in the sides of the crib to provide mooring places for barges.

Concreting Operations

All concreting both for the top and inside the working chamber, was mixed by hand, the gravel, sand and cement being loaded on a barge with a clear space left on the deck on which to mix. The concrete was shovelled into a bottom dump bucket and swung to the top of the crib by a derrick barge. When concreting in the working chamber the concrete was sent in through a concrete lock placed on top of the supply shaft nearest to where it was needed. There were four of these supply shafts in the caisson as shown in Fig. 1, and each of them was supplied with a bottom door of steel plate and with a long key to hold it shut.

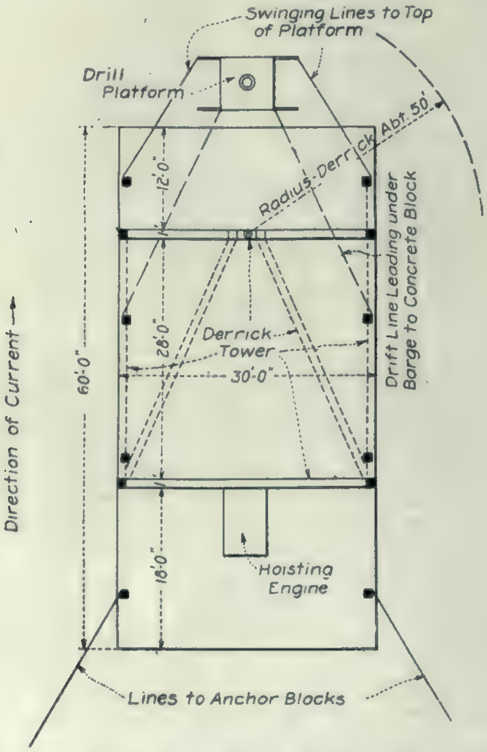


Fig. 8. -Method of anchoring derrick barge and drill platform while drilling holes for anchor bolts.

About 10,000 sacks of clay were deposited outside the cutting edge previous to starting work inside the caisson. To keep these sacks from being washed down stream by the current while they were being placed they were dropped through about 24 ft. of 24-in. supply shaft which was swung on a derrick and held with the lower end slightly above the river bottom. Several sacks were thrown down this tube after which it was raised slightly and others thrown in. When enough had been deposited in one place the tube was shifted along. By means of a sounding rod it was possible to keep close track of the location of the sacks.

When the area inside the cofferdam was cleaned out it was found that the rock bottom was from elev. 62 to elev. 64. This had to be excavated to elev. 61 and lower if the rock was not considered suitable at that elevation. It was finally excavated to about elevation 59 and cleaned up ready for the masonry of the intake tower.

The rock was drilled with Ingersoll-Rand Jackhamer drills and shot with very light charges of 40 per cent. dynamite as it was desired to shake the crib as little as possible and at the same time it was necessary to leave a perfectly sound stratum of rock for the foundation of the tower. The shooting merely loosened the rock after which it was wedged and pried up, loaded in scale boxes, hoisted by the derrick barges and dumped on the decks of barges. These barges were then towed ashore and unloaded.

When the rock had been cleaned up ready for masonry it was so late in the winter that it was considered dangerous to continue work. The work on the intake tower was therefore closed down December 29, 1913, and by January 6, 1914, all plant had been removed from the crib and from the power barge and all the floating equipment had been laid up in winter quarters.

The plant used on this work consisted of a power barge 32 x 130 ft., on which were three 60 h.p. locomotive type boilers carrying 110 lbs. steam pressure, one 675 cu. ft. per minute capacity straight line Ingersoll compressor, a 7½ kw. direct connected Allis-Chalmers lighting set (110 volt), a Smith 1 cu. yd. concrete mixer intended for use on the tower proper but which was not used on the caisson work, and a duplex pump for furnishing cooling water for the compressor and for other purposes. On this barge was also a dry house for the use of the "sand hogs" and other workers. The compressor was used for low pressure air for the caisson and later on was used for supplying high pressure air to run the rock drills. The boilers supplied steam for the compressor and for all the pumps. The power barge was moored at the downstream end of the caisson and made fast to it with steel cables. Steam and air lines on the crib and on the barge were connected through rubber hose in the case of the air and flexible metallic hose for the steam.

Two derrick barges were also used, one being the high derrick with which the anchors were set. On it was placed a Westinghouse compound air compressor with a capacity of 150 cu. ft. per minute, which supplied air for the grouting and also for the drills part of the time. The other derrick barge was a combined stiff leg and A-frame derrick with 32-ft. mast and 50-ft. boom set on a 30 x 60-ft. barge. In addition five material barges were in use.

This work is being done for the St. Louis water department. Mr. E. E. Wall is water commissioner, Mr. Gordon Black is chief engineer and Mr. E. C. Davis is resident engineer. The contractors for the work are The Fruin-Colnon Contracting Company and the Missouri Valley Bridge and Iron Company jointly, with Mr. C. H. Hollingsworth as general superintendent and Messrs. W. Naugle, R. E. Mosier and W. B. Converse as assistants on the various operations.

A hydro-electric plant is to be installed by the municipality of St. Agathe, P.Q. It is designed by Messrs. Ouimet & Lesage, Montreal, and is mainly for power purposes. The development will be on the North River and a power house of concrete will be constructed. The penstock is to be 1,000 feet long, and six feet 3-in. in diameter. The plant will be of two units of 250 h.p. each, operating under a head of 50 feet of water.

The Georgian Bay Ship Canal—Its Proposed Route and Its Economic Importance

By Sir Robert Perks, Bart.*

THROUGHOUT Canada the development of the vast natural resources of the country is almost the first consideration. How to people the prairies with healthy and industrious settlers; how and where to create new towns, giving them pure water, proper drainage, and open spaces; how to deepen, widen and bridge the waterways, and utilize the rapids and falls for the generation of electric power; the building of docks, harbors and wharves; the provision of gigantic grain elevators for storing and handling the ever-increasing crops; the irrigation of waterless lands and the creation of ready-made farms; the development of the fisheries and the exploration of the boundless mineral resources—these are problems with which Canada has to deal. But transcending all these in importance is the problem of transportation by land and water.

The Georgian Bay, Montreal and Ottawa Canal is a waterway which, when built, will connect the River St. Lawrence with the Great Lakes of Canada, and will for the first time permit ocean-going steamers of large draught to enter the inland seas, Lakes Superior, Michigan and Huron, thus gaining direct access to the Canadian and American ports which stud their shores. The construction of such a canal has for more than half a century been the dream of the statesmen of Canada.

The proposed canal is a waterway 449 miles long, formed by the Ottawa River and its tributary, called the Black River, the Mattawa River, then a series of three small lakes known as Talon, Turtle, and Trout Lakes. Here the canal crosses the watershed. The waterway thence passes through the larger lake called Lake Nipissing, and lastly continues down the French River, which discharges its waters into the Georgian Bay on Lake Huron. It will be seen by the map that this waterway utilizes for the greater part of its route a continuous chain of natural and existing lakes and rivers. Of this long waterway, 332 miles are a natural waterway 300 feet wide and over 22 feet deep.

Passing up the Black River, a distance of 27 miles, the steamers will be lifted at two locks and enter the Lake of Two Mountains, which is 20 miles long. The canal continues along the Ottawa River to the city of Ottawa, passing the towns of Oka, Point Fortune, and Hawkesbury, a distance of 129 miles from the entrance on the St. Lawrence. Upon this section the steamers are lifted up at two further locks to a total height of 140 feet above the level of the St. Lawrence. At Point Fortune and at Hawkesbury there are water powers capable of generating 278.000 horse power electric power. The whole of this electric power will be readily saleable at remunerative prices in the cities of Montreal, Ottawa and Hull, or to the factories which will be established, and the towns which will spring up along the route of the canal. The total electric power generated along the canal by the use of water power is estimated at nearly 1,000,000 effective horse power. This power will be used for lighting, traction and manufacturing purposes.

The total number of locks on the Georgian Bay Canal will be twenty-three—namely, three on the French River on the west side of the summit level with a fall of 70 feet, and twenty on the east side between Lake Nipissing and the St. Lawrence, where there is a fall of 633 feet from the summit over a distance of 357 miles.

The locks will be 850 feet long, with a width of 65 feet, and a depth of 24 feet of water on the sill. For many years the tendency of the steamers navigating the Great Lakes has been steadily to increase in size. In 1902 the largest vessel navigating the Great Lakes was 478 feet long, with a draught of 20 feet, and a carrying capacity of 8,500 tons. At the present time the largest ship is 617 feet long, with a capacity of 13,000 tons. The value of the steamship tonnage trading on the Great Lakes is estimated at £35,000,000. Eighty per cent. of this tonnage is American owned and American built. For four months of the year this immense capital lies in the ice-bound lakes. After passing the city of Ottawa, and the busy manufacturing towns of Hull on the opposite side of the Ottawa River, the canal continues up the Ottawa River, past the towns of Arnprior and Pembroke, till it reaches the Mattawa River. Continuing thirteen miles up this river, and ascending the Paresseux and Les Chines Falls by a series of five locks, the canal enters three small lakes called the Talon, Turtle, and Trout Lakes. It is proposed to lower these lakes to the level of Lake Nipissing, making a cut through the summit level for a distance of five miles. This section will be cut through the Laurentian rock.

Sir Robert Perks, Bart., who is now visiting Eastern Canadian cities.

At North Bay, on Lake Nipissing, extensive wharves and grain elevators will be constructed, and the canal will be widened to double width. At this point the main lines of the Canadian Pacific from Ottawa and the Grand Trunk Railways from Toronto converge and cross the canal. From Lake Nipissing the canal drops down the French River, a distance of eighty-three miles, by three locks. On this section there are two water powers, capable of generating

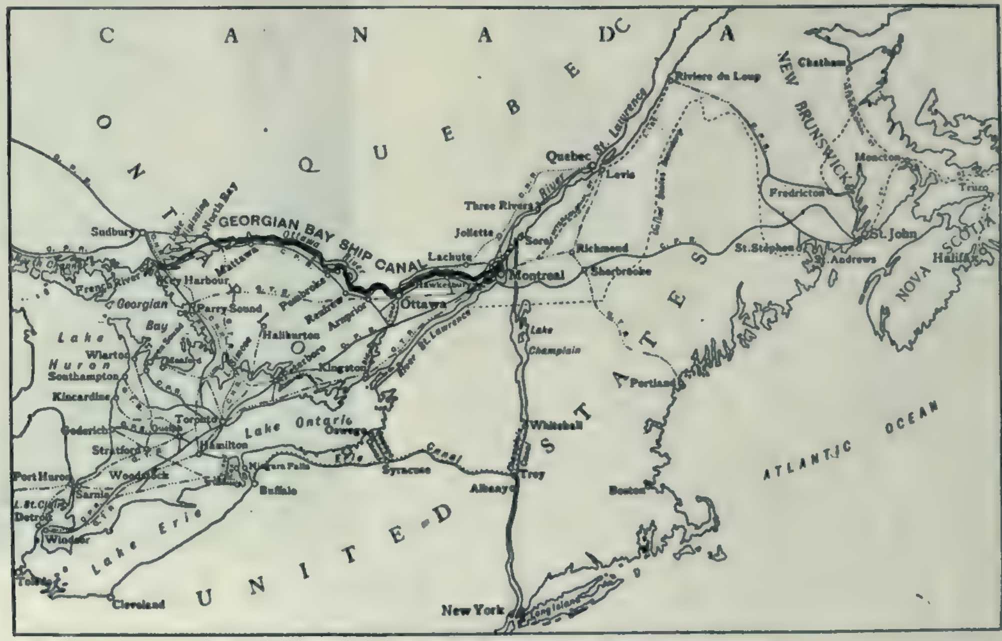
---

* Writing in the Journal of the Royal Society of Arts.

26,000 horse power. At the mouth of the French River the steamers enter Georgian Bay, one of the arms of Lake Huron, and then have a clear course to American and Canadian ports on Lakes Michigan and Superior.

Chicago and Milwaukee have together a population of nearly three million people. Their export trade is immense. By the Georgian Bay Canal route they are brought 412 miles nearer to Montreal than they now are to New York by the Erie Canal route, and they become 794 miles nearer to Liverpool than by Buffalo and the Erie Canal. What is of even greater importance, there is by the Georgian Bay Canal route water carriage all the way from Chicago to Liverpool or London, and grain goods may be sent without break of bulk direct to Europe. Fort William and Port Arthur will be brought 282 miles nearer to Montreal by the Georgian Bay route than by the Welland Canal and St. Lawrence route.

The time taken to make the journey through the Georgian Bay Canal will be 70 hours for the 449 miles. This is a little more than the distance from London to Edinburgh or Glasgow.



Proposed route of the Georgian Bay Ship Canal.

Various estimates have been made of the cost of constructing the canal. The works would probably take seven years to complete.

The cost must always depend to a very great extent upon the price of four main items at the time the works are built. These items are, land, labor, material and money. It will be safe to say that the cost, excluding the payment of interest during construction, and also excluding the cost of building the electric power houses, which will be erected as the demand for power arises, will be well within $150,000,000. The estimate of the Canadian Government is about $120,000,000.

The revenue of the canal will arise from the carriage of wheat, corn, and other cereals from the West; of timber and forest products, including pulp and pulpwood from the forests opened up by the building of the canal; of coal, iron, and other minerals; building material and general merchandise which cannot be carried profitably by rail. It is calculated that this traffic will amount to a total of at least 18,000,000 tons a year. The revenue from such tonnage, estimated at 50 cents a ton, will be $9,000,000. Deducting the working expenses of $1,000,000, there will be a net return of 4½ per cent. upon an outside cost of $150,000,000. The financial advantage arising from the building of the canal to the general trade and commerce of Canada will far exceed the direct results to the owners of the canal.

There has recently been completed at New Hazelton, B.C., a highway suspension bridge with a centre span of 451 ft. and a total length, including approach spans, of 600 ft. The bridge, which has a clear width of 9 ft., crosses the Bulkley River gorge, and is about 250 ft. above the water. The towers supporting the suspension cables are 65 ft. high, and are constructed of fir timbers. One of the towers rests on a concrete pier, while the other is on solid rock. The floor of the bridge consists of 3 x 4-in. fir plank, laid on 4 x 7-in. stringers, which rest on steel supporting pieces. The cables consist of Cradock's locked coil steel wire rope, 2½ in. in diameter. Each cable has an ultimate strength of 350 tons, and is anchored by means of two 3-in. steel bolts into blocks of concrete which weigh approximately 150 tons. The bridge has steel stiffening girders, designed to carry a moving load of 18,000 lbs. The suspension rods, which carry the floor system, are ¾ in. in diameter. They are spaced 4 ft. apart, and are fastened to the cable with clamps. The bridge was designed and erected by an English company, all of the steel parts having been imported from England. The length of time required in actual construction was about two months. The bridge is in a practically undeveloped section of British Columbia, and is at the site of a primitive wooden cantilever structure which was built many years ago by the Indians.

The master painters of Montreal have decided not to grant the increase in wages asked by the local union. The masters are of opinion that the present scale is high enough, and they are determined to maintain the principle of the open shop, paying each man according to ability. Last year an increase of 10 per cent. was voluntarily made.

Systematic Refuse Disposal for Small Cities and Towns

By Samuel A. Greeley, Consulting Engineer, Winnetka, Ill.

IN most communities with populations of less than 50,000, systematic methods of garbage or refuse disposal are not yet practised. In residential communities of less than 30,000, it is not uncommon to find three or four local scavengers making collections of house refuse from the wealthier residents comprising from one-fourth to one-third of the total population. These scavengers dispose of the house refuse so collected in very unrestricted ways. Part of it is dumped on waste lands, part of it is fed to pigs or chickens, and occasionally part of it is burned. The larger portion of the population, from whom no collections are made, dispose of their house refuse on their own premises or on adjacent vacant lowlands.

In cities with populations ranging from 30,000 to 50,000 a more extensive collection system may be found. It is, however, very unusual to find a comprehensive municipal service. In many of the smaller cities of Ohio the refuse is collected by contractors at a charge of ten cents per family per week. These contractors frequently burn the garbage and combustible refuse, dumping the remainder. This method is costly when compared with the annual cost for the service if the work is done by a city department. Where each householder pays directly to the contractor for the cleansing work, there are many families who do not consider the service sufficiently important to warrant the cost. They, therefore, oftentimes cause discomfort to their neighbors and endanger the health of the community by affording opportunities for flies to breed.

The disposal of manure in small communities is, fortunately, more easily accomplished than in larger cities. The farming areas are within easy hauling distance, and the manure is taken quite promptly to the farm on account of its fertilizing value. There are times, however, during the summer season, when the farmers are busy with their crops, that the manure is not removed as promptly as desirable.

This common condition in smaller communities, coupled with the growing desire for better community sanitation, has led many of the smaller towns to seek for better methods of refuse disposal. Garbage, ashes, dry rubbish and stable manure are the chief materials requiring removal and disposal. The first step generally taken by towns seeking to improve their methods of refuse disposal is to build a garbage crematory. Very little consideration is given to the best means of house treatment or of collection, or to other methods of final disposal. Not long ago I was called in to advise a town of about 5,000 inhabitants on the question of building a garbage crematory, to cost, including land and engineering expenses, approximately $20,000. Upon investigation, it was discovered that the collection service was reaching only about 25 per cent. of the people, so that the expense for the crematory would have benefited only a small part of the population. It was my recommendation that available funds be spent for improving and increasing the collection service, and until the collection service had been developed to include practically the whole town, that the house refuse be buried in a proper and scientific manner. In another instance I was called in to advise a town as to which of four bids received for a garbage crematory was the most advantageous. Upon examination it appeared that the bids had been submitted upon the city's specifications, requiring a plant of 12 tons capacity per 24 hours and a chimney 150 feet high. That was the extent of the specifications. The bids ranged from $8,000 to $30,000. It was manifestly impossible to make a satisfactory award, and the securing by the city of an adequately designed and properly built plant was doubtful under these conditions.

In view of these facts, it is worth while to consider what points should be included in proper measures to be adopted for improvements in refuse disposal in such towns.

House Treatment of Refuse

It would first seem proper to consider the best method of caring for the refuse at the point of production. House refuse should be kept in good metallic cans of such size that they can be easily handled by one man. In very small communities—with populations of 5,000 or less—ashes can ordinarily be disposed of near the premises, so that it does not seem advisable to place all classes of refuse in one receptacle. By separating the garbage the bulk to be removed is smaller, the disposal by burial requires less land, much of the garbage can be sent to farms for feeding to pigs, and the general cost of refuse disposal is reduced without seriously lowering the efficiency. In cities of from 30,000 to 50,000 the mixed refuse system, requiring only one can at a house and permitting incineration without the use of additional fuel, has many advantages. It is simpler for the householder; it results in cleaner cans; it is cleaner to handle in collection wagons, and affords less opportunity for flies to breed. In such small cities garbage does not have the value for reduction purposes that it has in the larger cities, because the cost of handling at the reduction plant when distributed over such small quantities of garbage is prohibitive

One feature of the house treatment which is troublesome in smaller towns, comes from the tipping over of the house can by dogs. Wrapping each day's production of garbage in an old newspaper and placing the bundles in the can have largely reduced this trouble in places where it has been tried. Wrapping the garbage also keeps the can clean, reducing the attraction for flies, and is well worth consideration. It cannot be used if the garbage is fed to pigs, and would add a certain cost to the burial of garbage, but is most desirable if the garbage is to be burned.

Collecting the Refuse

The collection of refuse in small communities is, perhaps, that part of the general problem through which the greatest improvement can be effected. The most important elements of the collection service are:

(1) Frequent and regular collections.

(2) Intelligent drivers, who are willing to take pains to do the work at each house in a cleanly fashion.

(3) Properly selected collection wagons, kept clean and well painted.

It is surprising to what extent the design of the collection wagon affects the cost and efficiency of the results. The wagon should be as large as is consistent with local grades and roads. The loading height of the wagon should be at a convenient distance from the ground, so that the collector can easily empty the can into it. The arrangement for unloading the wagon should be quick and simple. Bottom-dump wagons are the best, but cannot be used for raw garbage unless it is wrapped, because the bottoms are not waterproof. It is serviceable for mixed refuse. The rear-dump wagon, tilted by a hand-turned gear at the front, has given success in practice. The method of covering the wagon is especially important. I think the most satisfactory covering is a tight fixed roof, arched over the top of the wagon at sufficient height to give a free space above the level of the garbage in the wagon and to allow trap doors in the side of the wagon for emptying the can. Wagons of this type are in general use in Germany. Wagons having capacities of about three cubic yards are desirable.

Final Disposal of Refuse

It is frequently the case that in small quantities the disposal of house refuse receives more attention than it deserves. If the garbage is removed promptly and regularly from the house to some isolated point of disposal, and proper attention is given to the upkeep of this point, there are several methods for disposal available. The garbage can be buried in the ground, be fed to pigs or burned. The burial of garbage is quite satisfactory if properly done. It requires skillful attention. It depends upon aerobic bacterial decomposition for its accomplishment. Therefore, the garbage must not be placed so deep that the air cannot penetrate, and the area of garbage must not be more than the soil bacteria can reach and digest. When these two factors are observed, the burial method is the simplest and most fool-proof available.

Feeding garbage to pigs is also a satisfactory method of disposal, if properly done. Feeding troughs and pens for the pigs much be made up so that they can be washed and kept clean. About 75 pigs are required to dispose of one ton of garbage per day. Nuisances will arise from piggeries of this size if they are not kept clean. There should also be some method of sorting the garbage before feeding it to pigs, so that stale garbage may be discarded and buried or burned. In some places it has been found expedient to disinfect the garbage by boiling it in large cauldrons before feeding it to the pigs. In such cases the cooked garbage is commonly used only as a base for the feed given to the pigs. The method is a most profitable one, and warrants consideration in small cities where isolated farm sites are available.

The disposal of garbage and other combustible refuse by incineration is accomplished in specially designed furnaces, and if the garbage is mixed with sufficient ashes and rubbish the resulting material will contain sufficient carbon to be combustible. Frequently, however, in small towns, it is desirable to burn the garbage by itself. Garbage alone is not combustible and requires an additional fuel. Garbage crematories require careful design and good construction to insure satisfactory and durable results in operation. A plant of this sort—when properly carried out—can, however, be located quite centrally without creating a nuisance, this reducing somewhat the cost of collection.

Garbage crematories to burn garbage with some rubbish, manure or night-soil are the commonest type of furnace in small communities. They consist of a feeding platform on top, below which is a drying hearth of brick. This hearth receives the wet fresh garbage charged into the furnace. Below the drying hearth are fuel grates on which coal is burned with the dried portion of the garbage. The drying hearth with the wet, cold garbage above and the hot coal fire below is in a critical position and deteriorates rapidly if not properly built and designed. Some furnaces are built with a secondary coal grate near the chimney to consume the unburnt gases of combustion. These grates are often neglected and not used. Crematories can be operated by forced or natural draft. A high chimney and strong natural draft is good practice. The coal required amounts to upwards of 200 pounds per ton of garbage, depending upon the efficiency of combustion required by the community and the character of the garbage and other materials burned. The cost of construction will range from $600 to $1,000 per ton daily capacity. The cost of operation will range from about $1 to $1.50 per ton, but local conditions may alter these limits.

In some towns gas garbage burners have been installed by private individuals in their kitchens. These will cost about $3 per month to operate for one family and will not be wholly free from nuisance. They are useful where dumping or burial is difficult and there is no adequate municipal service.

These considerations should indicate clearly the advisability of tackling the refuse disposal problem scientifically in order to get the best service for a reasonable expenditure.

Sanatorium at Fort Qu'Appelle, Sask.

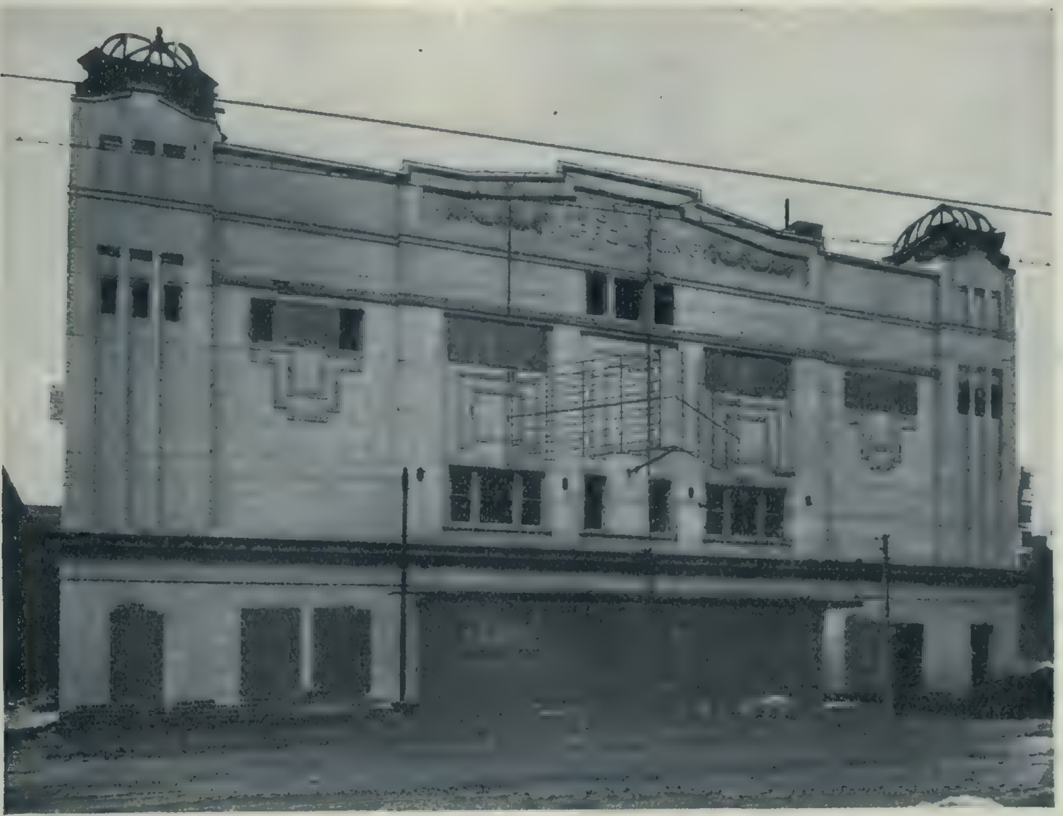
THE Saskatchewan Anti-Tuberculosis League are constructing a sanatorium on the north shore of Echo Lake, one-and-a-half miles west of the village of Fort Qu'Appelle, Sask. The structures to be erected this year are the Administration Building, Superintendent's residence, Power house and two nurses' cottages, and the lay-out has been so arranged that additional cottages may be erected at any time in the future. These buildings, when completed, will cost in the vicinity of $220,000.

The Administration building is three storeys high, of reinforced concrete and brick construction. It has a frontage of 140 feet, and a depth of 32 feet with a 63 feet wing on the back. The Superintendent's residence has two storeys. It is 38 feet by 35 feet in size, with frame construction and stone basement. The two nurses' cottages are each 100 feet by 31 feet, with two storeys. Like the Superintendent's residence they are frame buildings with stone basements. The power house is 88 feet by 52 feet and is constructed of brick with steel roof.

Underground tunnels, 4 feet by 5 feet, run from the power house to all the other buildings, and the water pipes, electric wires, etc., will run through these. The water is to be pumped to a reservoir placed upon the top of one of the high hills at the rear of the buildings, and from thence it will be piped to each building.

The architect is Mr. J. H. Puntin of Regina, and the contractors are the Parsons Construction & Engineering Company, Limited, of Regina.

The completion of the Lower Bari Doab Canal, the third section of the triple canal project in the Punjab, proves the greatest enterprise ever undertaken by British irrigation engineers. This canal is unusual in construction, in that it actually crosses upon a level the important River Ravl. The new waterway has cost about $7,500,000, and it is expected that it will irrigate over 871,000 acres of crop.



Shea Theatre Company's New Hippodrome which is now nearing completion at Toronto.

Structural Features of New Toronto Theatre

(Staff article)

THE last word in theatre construction may be said to be embodied in the new Hippodrome which has just been erected for the Shea Theatre Company of Toronto. The building, whose graceful facade adorns the south-west side of Terauley street, has a frontage on Terauley street of 111 feet. It is built of steel, reinforced concrete, tile and brick throughout, and is completely fireproof in every part. The side walls and back of the building are faced with gray stock brick. The exterior on Terauley street is finished in white enamelled brick and hollow tile porous terra cotta, and on either corner of the structure are towers of glass with copper framework. A massive copper marquee extends the entire length of the 46-ft. entrance and the whole width of the sidewalk. In the construction of the theatre over 550 tons of steel and iron have been used for the structural work alone, while a great quantity in addition has been used for the stairs, fire escapes and other equipment. Underwriter standard fireproof doors and a complete sprinkler system, with the usual arrangement for standpipes at every necessary point, have been installed as additional precautions against fire. On either side of the building wide fire escapes have been erected, with numerous exits leading thereto and to the passageways at both sides of the building. The fire escapes instead of landing on the areaways, as has been the custom in the past, lead into fire towers set within the building line. In this way they remove from the areas at the sides of the building all possible obstruction to free egress.

The balcony is built on the new system of cantilevering that has but recently come into general practice. It has an overhang of 67 feet. The cantilevering rendered unnecessary the erection of obstructive columns on the first floor. The dimensions of the auditorium are 111 feet by 125 feet. The theatre will have a seating capacity of about three thousand, divided equally between the orchestra and the balcony.

The auditorium proper is separated from the exterior walls by spacious lobbies at the sides. These lobbies serve the useful purpose of promenading space and also prevent the possibility of cold air entering the auditorium through the side exit doors. These vestibules will be connected direct with the private boxes as well as with the orchestra floor and balcony, and at the same time will have safety exits direct to the areaways at the sides of the building. The ceiling under the balcony has been lowered and the space between it and the balcony floor is converted into a commodious mezzanine reached by two marble stairways, each 9 feet wide, located at either side of the lobby. The rise to this mezzanine is comparatively slight and from it the public enter on the level, thus rendering unnecessary a tedious climb to the balcony itself.

The mezzanine is fitted with a large parlor for the ladies and a smoking room for the men, both of which face Terauley street, and these apartments are fitted with large windows. The mezzanine being so centrally located between the two floors of the theatre will prove one of the chief attractions of the new hippodrome

On the first floor is located a still larger parlor for the ladies, taking up the entire frontage of the building at one side of the lobby. In the basement is also an additional smoking room reached from the rear of the auditorium by a short flight of stairs. This room has windows opening on the side area. The lobby is 46 ft. wide and handsomely decorated in the prevailing tones of the theatre proper. The main ceiling of the auditorium and the ceiling of the orchestra under the mezzanine are beautifully panelled and beamed with ornamental plaster work. The private boxes and proscenium arch are as elaborate and artistic as modern ideas can make them. A massive dome in the main ceiling, illuminated by indirect lighting, adds greatly to the pleasing effect of the auditorium. The prevailing colors of the decorations are creams, rich golden tone and soft grays, with the ornamental relief work finished in old ivory and brilliantly gilded. The sounding board is enriched with handsome Mural paintings.

The proscenium girder which spans the stage opening is 50 feet in length and weighs 16 tons. The fact that some of the cantilevers weigh 25 tons conveys some idea of the heavy steel work used in the structure. The six dressing rooms are located in three tiers at the sides of the stage and are separated from it by a fire wall in strict conformity with the most modern ideas and requirements. The partitions are of terra cotta 6 in. and 4 in. tile. The flooring throughout is of concrete, and the roof is of Barrett specification. The doors and casings of the entire building and the wainscotting of the auditorium are finished in a rich mahogany. The lobby is wainscotted in marble and with the marble columns in the auditorium, the finish of the walls and ceilings throughout lend a pleasing appearance to the whole.

The entire building is heated and ventilated in the most modern and approved manner. The lighting scheme was carefully thought out by the architects, and both direct and indirect systems of lighting have been installed.

Construction was begun in May, 1913, after excavating, and the theatre will be opened to the public during the present month. Apart from the cost of building space the structure involves the expenditure of about $250,000.

The architects were Messrs. Leon H. Lempert & Sons, Rochester, N.Y., with whom was associated Mr. C. J. Read, architect, Toronto. The general contractors are Messrs. Fred Holmes & Sons, Toronto. The steel work was carried out by the Dominion Bridge Company, having been designed by Mr. F. Meister, engineer of New York. The Sun Brick Company of Toronto supplied the stock brick for facing the side walls, also a considerable quantity of the backing-up brick. The York Sandstone Brick Company and the Toronto Brick Company furnished a large quantity of brick for interior work. The ornamental plaster work was done by the firm of Maltby, of Corning, N.Y.; plain plaster work, Mr. E. J. Currie, Toronto; ornamental iron, stairways and fire escapes were supplied and erected by the Dominion Ornamental Iron Company; the painting was done by Mr. W. M. Weekes, Toronto; the Mural decorations were carried out by Mr. Geo. Brande, Chicago; the fireproofing was supplied by Mr. E. D. Hoeffler, of Buffalo; roofing and sheet metal, Douglas Brothers, Toronto; plumbing, heating and ventilating, Mr. Fred Armstrong, Toronto; carpenter work, Mr. A. B. Coleman, Toronto; electric wiring, etc., the L. K. Comstock Company, Toronto and New York; electric fixtures, Messrs. MacDonald & Willson, Toronto; terra cotta, the Atlanta Terra Cotta Company, New Jersey; enamelled brick, American Enamel Brick Company of New York; and the marble and terazzo was supplied by the Lautz-Dunham Company, Limited, Toronto. The chairs were supplied by the American Seating Company.

How Bridges Expand

THREE years ago I made a series of observations of steel railway bridges erected on various lines of the New York, New Haven & Hartford Railway, to determine the action of the expansion bearings, says a writer in the Engineering News. The bridges on which the observations were made are all relatively new, having been erected during the past ten years. In all, 45 observations were made, on as many different bridges. Of these 16 were pin-connected trusses, varying in length from 182 to 217 feet; 11 were rivetted through trusses, 70 to 145 feet in span; and 18 were deck plate-girder bridges, 70 to 111½ feet in span. The winter temperatures during which observations were made (1910-11) ranged from + 15 to + 56 deg. F., and the summer temperatures (the following summer) ranged from 45 to 86 deg. F. The variation from high to low temperature during a single set of observations ranged from 18 deg. change as a minimum to 54 deg. change as a maximum.

To complete the coefficient of expansion, it was necessary to know the temperature of the bridge at each observation. It might be thought that very precise temperature readings would be necessary, but the following observation indicated that this was not the case: a 217-foot pin-connected truss span was watched while the atmospheric temperature was rigidly rising under the warm rays of the morning sun. It was noted that a movement occurred at the roller bearing for every 3 to 5 deg. F. rise in temperature, and whenever such a movement occurred there was a loud noise. The bridge and its bearings were in good condition. It is concluded from the observations that, even under nearly ideal conditions of free movement the expansion movement of a bridge does not take place smoothly and continuously.

A mine-fire gallery has been built by the U. S. Bureau of Mines at its Pittsburgh experiment station. This is a steel tube 6½ ft. in diameter and 27 ft. long, laid in a deep trench, lined with firebrick and mineral wool, covered with 2 ft. of earth, and with its ends stopped by 13-in. brick walls. The chamber has been made as nearly air-tight as possible and insulated against the escape of heat generated within. At one end is a motor-driven fan and air meter, while at the other is a stack which can be opened or closed. At intervals along the top of the gallery are small pipes for withdrawing samples of air or gasses inside, or for inserting pyrometers. The gallery will hold six to eight tons of coal when one-third full. It is intended to place different kinds of coal or waste in the chamber and study spontaneous developments under various conditions. Experiments are planned on controlling fire by reducing air supply or sealing. Progressive changes in composition of the gases, etc., will be followed out and temperature measurements made to secure data for solving practical problems in subduing mine fires. It is claimed that this is the first attempt to investigate this problem with experimental apparatus on a mining scale and with full control of surrounding conditions.

General view of Kilgard Fire Clay Company's plant at Kilgard, B.C. Note immense mountain of raw material in background.

The Kilgard Fire Clay Company's Plant at Kilgard, B.C.

(Staff Article)

THE works of the Kilgard Fire Clay Company, Limited, are situated in British Columbia at Kilgard, in Sumas municipality, adjoining the international boundary line. Kilgard is located on what is at present a branch of the Great Northern Railway, but which will eventually be the main line of the G. N. R. between Spokane (Wash.), and Vancouver, B.C. The plant site is on the southeast side of Sumas Mountain, about 65 miles distant from Vancouver. The company have erected a large boarding-house to accommodate 140 men, a store and several cottages and a small school house. They have secured a small library from the provincial government, and are doing all they can to make their employees comfortable.

A small reservoir has been built on the mountain directly behind the town which supplies water for the works as well as for the town. It is possible to secure 160 pounds pressure in case of fire.

Nature has provided an inexhaustible clay supply in Sumas Mountain—ranging in quality from the highest grade fire clays to the red burning vitrifying shales. The clays lie in horizontal strata behind the factory. The lowest is slightly above the plant so that there is gravity haulage in all cases. The strata vary in thickness from six feet in the fire clays to sixty feet in the upper shales. In nearly all cases there is a hard overlying material which provides a good roof for the mining.

A main gravity 3-rail tram line is located directly behind the factory leading from the crusher up to the storage bunkers. The storage bunkers are placed above the tracks at points conveniently located for the mines. The tram line is twelve hundred feet long, and has a 16 per cent. grade at the top which gradually decreases to 4 per cent. at the bottom. There is a passing track at the centre point. As the system is a three-railed one, the passing track requires no automatic switch. It has been found after a year's operation that the system is in every way satisfactory. The variation in grade may lead to the belief that it would be difficult for the loaded cars when they were running on the 4 per cent. grade to pull the empties up the 16 per cent. grade. This is not the case, however, as the low grade is at the low end of the system, and sufficient momentum is gathered when the loads are on the 16 per cent. grade to carry the cars to the crusher or low end. The clays are delivered from the mines to the storage bunkers on the tram line in several ways. Three mines are well above the tram up a steep hill. The clays are dumped into a chute and slid down to the bunkers. The chutes are 33 per cent. grade and steel lined. Heavy bumper doors are located at intervals in the chute to check the speed. These are hung on hinges from above. The bunkers are so arranged with inclined bottoms and doors that the clay is easily dumped into the cars on the tram line. One man can operate the system with ease and has handled at the rate of 600 tons in ten hours allowing 10 per cent. for loss of time.

One of the best features of this method of clay delivery is its adaptability to making mixtures of clays. Should it be desired to make a mix of fifty per cent. of two clays, one bunker being at the head of the tram line and the second bunker at one-third of the way down, the operator will fill one of his cars at the upper bunker and then lower the two cars down to the other bunker, where a second man will fill the second car with this clay. There are two cars on each track, these two cars being transferred down to the lower end of the line and dumped into a hopper above the crusher. While the cars are being dumped one of the empties at the upper end is being loaded. Side dump cars are used. The variation in the tram grade lends itself to this method of mixing clays, as there is only one loaded car from the upper bunker down to the bunker where the second car is filled, and it and the second car (which is empty) have to pull the two empties back from the foot of the line. During this first half of the trip one load is going down the 16 per cent. grade while the two empties are coming up the 4 per cent. grade.

(For a full description of this system see the Transactions of the American Ceramic Society, Year 1913, article by Mr. E. H. Riddle).

After the clays are crushed they are elevated and delivered to the storage bins in the factory to be ground. When the clays are mixed on the tram line it is easy to see how thoroughly mixed they are at this stage. There is little chance for error in the mixing process, as it is not likely the tram operator would forget to fill his second car at the halfway bunker. The old method was to mix the clays in the factory storage bunkers in small lots, by shovels, etc., employing unskilled men who worked in an out of the way part of the mill. The cost was not only heavier, but chances for error were much greater.

The Plant

The plant is located at the edge of the mountain with a rather steep grade at the rear and a slowly sloping yard at the front, which affords plenty of space for the kilns and yard storage. The spur track is arranged at the front of the yard and depressed so that the loading dock is on a level with the car floors.

The construction is frame of the usual mill type. The plant is designed for the manufacture of face and fire brick and sewer pipe. The machinery for the brick is in one end of the building and the sewer pipe machinery is located in the other end with the power house between. In front of these are the drying buildings used for the drying of sewer pipe and fire brick. The face brick are dry pressed and dried in the kilns. This part of the building is three hundred by eighty-five feet and three and one-half storeys high.

Machinery

The grinding of the clays for all three departments is done by the same method. The crushed clay in the storage bins is let out through the bottom into 9-ft. dry pans where it is crushed fine enough to pass through slots 3/32-in. wide and one inch long. It drops through these slots into a hopper bottom which leads to an elevator boot. These pans are of heavy construction weighing about 36,000 pounds each. They are round horizontal pans 9-ft. in diameter with a 12-in. rim or flange around them. The pans are held on and turned by a 6-in. vertical shaft running up through the centre and supported on the bottom by a bronze step, on top of which is a horizontal bevelled crown gear keyed to the vertical shaft. This is rotated by a vertical bevel pinion on a horizontal shaft. The pan revolves at 30 r.p.m. The crushing is done by means of two mullers or crusher rollers which are 48-in. in diameter and 12-in. wide. They are very heavy, being made of cast iron with chilled tires to keep them from wearing. These mullers rest on the pan bottom about twelve inches each side of the center shaft and are held in position by means of a shaft running through them to slotted guides on each side of the pan. There is a yoke in the centre between the two mullers around the centre vertical pan shaft which holds the muller shaft. As the pan revolves the mullers also revolve as they are resting on the pan. They are held in position by their shaft. When the clay is dumped in the revolving pan a scraper guide in front of each muller guides the clay under the muller where it is crushed. The instant it passes from beneath the muller, centrifugal force throws it to the outside of the pan where it is held in by the pan rim or flange. The outside 15-in. to 18-in. of the pan bottom is full of slots, so that the clay in being thrown by centrifugal force from under the mullers to the pan rim passes over these slots and all the clay which is sufficiently fine drops through the slots into the hopper bottom. The clay which is too coarse and goes to the pan rim is again caught by the second scraper and guided under the second muller where it is again crushed, etc.

All the fine clay which has dropped through the pan bottom into the hopper and elevator boot is lifted in the ordinary type belt and bucket elevator up into the screen room about 40 ft. above the pans. The clay passes in the buckets over the head wheel of the elevator and is thrown free of the buckets on to perforated steel plates. These plates are four feet wide and arranged in sets twenty feet long on an incline of 40 degrees from horizontal. The clay runs down the screen and all fine particles fall through the perforations while the coarse particles run down the plates to a tailings chute which returns them back to the dry pans to be reground until fine enough to pass through the screen perforations. The clay which has passed through the screen perforations is caught in a chute underneath and carried into ground clay bunkers. The fineness of the screening depends upon what the clay is intended to be used for. For making fire brick the clay is not screened at all, while for face brick (dry pressed) it is screened through perforations 3/32-in. in diameter. For sewer pipe the size of grain varies with the size of pipe to be made. The finer the better for securing a dense body, but if the clay is too fine it requires a longer time to burn it. The general practice is to use fine clay in the small pipe which have thin walls and a coarser clay in the larger pipe with thicker walls. As stated above all clays go through the same process to this stage and then receive different treatments from now forward, the treatment depending on the class of ware to be manufactured.

Sewer Pipe

The ground clay bunkers for the sewer pipe department are built on the second floor of the factory and arranged with hopper bottoms so that the clay can be taken out by gravity. Directly under the bins are the wet pans arranged in tandem. These pans are very similar to the dry pans described above with the following exceptions. They are eight feet in diameter instead of nine and have solid bottoms, i.e., no screen plates in them, and the mullers are about half as wide as those in the dry pans. These pans are used for tempering the clay, that is, mixing it with water in sufficient amount to form a plastic mass stiff enough to be worked or modelled by hand. The method of mixing the clay and water is to let about two hundred pounds of clay drop into the revolving pan and at the same time open the valve and let in sufficient water. The amount of water is determined by practice only and depends on the skill of the operator. The reason of this is that the character of the clays, size of grain, amount of moisture in the ground clay, etc., all effect the amount of water required and these are all variables. The clay revolving with the pan is caught by the scraper guides and forced under the mullers and so on around the pan. The scrapers are arranged so that they not only guide the clay under the mullers but also turn it over as a plough does. This constant turning and kneading soon thoroughly mixes the clay and water and develops plasticity, the amount depending on the character of the clay and the length of time the charge is left in the pan. The amount of water required makes the clay wet enough to form balls which do not stick and are stiff enough to go to the outside of the pan, being driven by centrifugal force. The charge is taken from the pan by means of a shovel. This shovel is about ten feet long and is held over the top of the pan on a universal jointed fulcrum. The fulcrum is about three feet from the shovel end of the shovel and holds it in such a way that the operator can lift up the handle end and the scoop will dip down into the pan just inside the rim. The pan revolves against the shovel point so that when it is lowered into the pan the clay runs up on to the shovel. When it is filled the operator pulls down on the handle lifting the shovel of clay up out of the pan, and then by pushing the handle in towards the pan and giving it a turn, he can throw the clay over the pan rim into a hopper which carries the tempered clay into an elevator boot.

As mentioned above there are two pans arranged in tandem. They are placed in line and far enough apart so that the rims are about three feet apart at the nearest point. The hopper is between the two and can be used for both. The pans revolve in opposite directions and the operator stands at the edge of the hopper between the pans and both pans revolve toward him. Each pan has a shovel attached. In operating the pans are filled and emptied alternately so that while one pan is being charged the other is being emptied and no time is lost in the operation.

The tempered clay which falls into the elevator boot is caught up on flat buckets and lifted up about forty feet. The buckets being on a belt which is sufficiently off the perpendicular, i.e., leaning back far enough so that the clay will not roll off the flat buckets. The elevator dumps the clay onto the storage feeder belt which is a 24-in. belt about twenty feet long with side boards so that a large quantity of clay can be stored on it. It is arranged with power drive controlled by an operator who can move it at will so as to distribute the clay along the belt as well as to unload the clay from the far end as the clay is required for further operations.

From here the clay goes to the sewer pipe press. The press, which is known as the one rod type, stands three and a half storeys high. It is made up of two direct connected cylinders known as the steam and mud cylinders. The steam cylinder is on top and the mud cylinder beneath, the space between the two being about four feet. They are supported on a heavy steel frame and held high enough so that the bottom of the mud cylinder is even with the ceiling of the second storey. The steam cylinder has a diameter of 44 inches and a 60-in. stroke, while the mud cylinder is 21-in. in diameter. The rod is very heavy and has a plunger on the lower end of the diameter of the mud cylinder. When the piston head is lifted to the high end of the steam cylinder the plunger is about 18 in. above the top of the mud cylinder, thus leaving it wide open. A chute is built from the end of the storage feeder belt leading down into the mud cylinder. The feeder belt is placed high enough so that the chute is sufficiently steep for the clay to roll from it when pushed off the end, down into the mud cylinder. This operation is controlled by the operator who also controls the distribution of clay along the belt, as described above. Just enough clay is let into the cylinder to fill it up. When filled, the pressman, who stands on the second floor, controls the steam valve of the cylinder by means of a lever, turns the steam into the cylinder above the piston head and forces the rod down, thus pushing the plunger and clay down into the mud cylinder. The mud cylinder is so constructed that different dies can be put on the bottom of it. A different die is used or each size of pipe.

Sewer pipe dies consist of three pieces, known as the "bell," the "former" and the "outside" die, which not only determines the shape of the outside of the pipe, but also makes the socket when the former is fitted in. The bell is a bell shape casting whose extreme outside diameter is the size of the inside of pipe. This bell is held up in the press on a stem which is fastened directly under the centre of the mud cylinder by means of a three-legged spider, the spider legs reaching out from the centre and cast into a ring bolted on the nozzle of the mud cylinder. These spider legs are made as thin as possible and have vertical corrugations. These corrugations are hardly noticeable at the top of the legs but are so pronounced at the lower edge that they form a wavey knife edge. This is done so that the clay passing down through the machine under pressure and passing by, these spider legs is roughened up to such an extent that it will reunite directly under the legs to form a solid mass again.

The outside die is bolted on to the ring and tapers from that diameter gradually in to a ring the size of the outside of the pipe proper. This point is directly in horizontal line with the end of the bell. Looking up from beneath, the position of the bell and outside are such that the orifice formed is the exact shape of the main body of the pipe without the socket. When the clay is forced down through this opening it is in the form of a pipe. In order to form the socket on the pipe the outside die continues below the end of the bell but the opening expands out and forms a shoulder the width of the outside of the socket and then remains at this diameter and extends down the length of the outside of the socket. In order to form the inside of the socket there is a rod directly beneath the centre of the bell which slides up and down in guides under the floor. This former rod, as it is called, is counterbalanced and controlled by the pressman by means of a belt driven friction pulley. Sitting on the top of the rod is the third part of the die or the former. This former is the exact shape of the inside of the socket and is made with projecting lugs so that when it is lifted up against the bell these lugs are pushed into hooks on the outside die. This locks the whole die together and leaves a space on the inside which is the exact shape of the socket of the pipe.

Close view of Kilgard plant, showing detail of kilns.

When this is locked the operator again throws his steam on top of the piston head and pushes it and the plunger down, thus forcing the clay in the mud cylinder down into the locked die. There is a row of issue holes in the former which permit the air to be forced out as the clay is forced in and the clay is allowed to continue to be pushed in the die until it also issues out through the issue holes, thus indicating that the socket is formed. The pressure is then released by cutting off the steam pressure, the former unlocked by twisting it in the rod and the pressure again applied. This pressure pushes the former rod down at the same time pushing the clay out of the die through the orifice formed by the bell and throat of the outside of the die, thus making the rest of the pipe. This pressure is maintained until the pipe is the desired length, when it is stopped. The former is pushed on down, leaving the socket clear and a socket board is placed in the socket. This board is held by two men called "turners," and the pipe is then cut from the die at the top. It is then placed in front of the press on a bench and cut to length with a piano wire cutter supported from above, on a pipe with a forked bottom, the wire being stretched on the ends of the two prongs. When cut the turners turn the pipe so that the spisket end is down, and put it on a drying board on a truck. All sizes of pipe from 4-in. to 24-in. are made in this manner by using the different sized dies. In nearly every case the turning has to be done differently on account of the differing weights. For example, a 4-in. pipe weighs about 19 pounds, while a 24-in. pipe weighs 500 pounds at the press. The large pipe, 18-in. and up, are turned on floor cradles while the 16-in. to 10-in. are turned on bench cradles and the 8-in. and less turned by hand. It is not unusual to turn out two miles of four-inch or 2,000 feet of 24-inch pipe in a day's run (10 hours).

As the above description shows, the processes from the tempering of the clay on are intermittent and depend a good deal on the skill of the men. The mud cylinder of the pipe press has to be charged regularly and this is done by lifting the plunger clear of the mud cylinder and refilling with clay from the storage feeder belt. Large pipe sometimes require the mud cylinder to be filled twice to make one pipe, with one charge. There are many minor details of the press of great importance, such as the steam die hoist used in lifting the heavy dies into place when changing from one size to another, the cutter, etc.

Crusher plant where all clays are received into the factory. The trestle shown is a tram line from clay mines.

When the press is operating at full speed the exhaust steam is a tremendous item. In most plants this is wasted but in the Kilgard plant the exhaust is received in a large tank and distributed through the building in the dryer coils and is sufficient to heat the entire building when the press is running. Live steam is used at night.

The drying of the pipe is a very important operation, and with the clays used, can be carried on comparatively quickly. When the pipe leaves the press they are put on the dry floors in rows and the heat is put in the coils in the ceiling so as to dry the pipe from the top or socket end down. It is done this way so that the sockets will be hard enough to turn the pipes over while the spigot end is still damp to allow being fettled. As the drying continues, more heat is turned on and kept on until the pipes are bone dry. This requires anywhere from two to seven days, depending on the size of the pipe.

The drying system is a very important and expensive piece of construction and is a thoroughly complete piece of work at Kilgard. The coils are arranged so as to be controlled individually and they are made up of the live and return headers with direct connected 1¼-in. pipe 18-in. centres on the lower floors and 30-in. centres on the upper floors. These headers are 16 ft. long and the coils from 30 to 50 feet. The live steam headers are fed with steam from both sides by main feeders leading from the exhaust tank as described above.

The return of the water is accomplished by the use of a vacuum pump and Dunham Blast Traps which permit the pump to suck out only the water and air. They act almost immediately and are very satisfactory. From the vacuum pump the water goes into a separating tank where the air and water are separated and the water flows into a hot well receiver from which it is pumped back to the boiler. Wherever this system is used a thoroughly good oil separator should be employed. The dry pipe are ready for setting in the kilns and burning.

The plant is equipped with six thirty-six-foot inside diameter down draft sewer pipe kilns and two more will no doubt be added shortly. The burning of any clay wares is of vital importance to the manufacturer and the kilns, as well as the burning, should be studied with extreme care.

At Kilgard the kilns are arranged in batteries of four with one stack between them. The object in this is that the stack will always be warm so that when a cold kiln is lighted it will have the warm stack to help out the draft at the start. The kilns are circular and have fourteen fire boxes around them with horizontal grate bars. The fire boxes extend through the walls of the kilns so that the coal is shovelled in the doors outside and the heat created passes up into the kilns. Directly around the fire boxes inside the kilns is a brick wall with an opening at the top so that all the heat coming from the boxes goes right up to the top of the kilns. These walls are known as bags and not only throw the heat up but also protect the ware directly in front from too severe heat treatment. The walls of the kilns are about ten feet high outside and seven feet inside. At this point the crowns start to turn and form the roofs. They take the form of an arc and the crowns are about 15 feet above the floor at the centre. The floors are made of perforated or checker brick supported with walls running parallel across the kiln and about 15 in. high. These walls form flues. Beneath the brick floor on which these walls rest is another set of flues which radiate out from a centre well hole. There are fourteen of these radial flues, one between each fire box. Opening up from the flues at about three places are openings into the upper part of the kiln. From the well hole there is a main flue about three feet square which leads to the stack. This flue is nearly eight feet under ground. All these flues and openings are proportioned according to equivalent areas and the distances from the main flue, etc. When the fires are lighted the heat will rise up in the kilns from the boxes through the bags and then be sucked down through the perforated floor into the radial flues, then to the well hole, through the main flue and up into the stack. It is easily seen that it requires considerable draft to create this long down draft and hence the advantage of having four kilns to one stack so as to keep it warm. The stack is also divided into four parts so as to keep each kiln independent. This is necessary, as when a kiln gets hot, so much draft is created that it completely uses up all the available part of the stack and acts as a damper to the cooler kilns and retards their burning instead of helping it out, if the divisions are not in the stack.

The ware is brought out of the building by means of gravity elevators which let the truckloads of pipe down from the upper floors. It is then wheeled into the kilns and placed in rings around the kiln starting at the outside and working towards the centre, always leaving a backing out space in front of the door. The pipe are placed one on top of the other four high for pipe two feet long, and three high for pipe two and a half feet long. All bottom pipe are set on rings of the unfired clay made of sections of pipe and are always the same diameter as the pipe placed on them. The reason for this is that the pipe shrink in burning and the bottom pipe with the weight of the other pipe on top is so heavy that if it was setting on the bottom made of fired brick with the shrinkage all out, it would be bound to crack in trying to shrink. By placing on these short rings they do the cracking and leave the pipe in good shape. The rings are about 3 in. high.

Coal is used for the sewer pipe burning, while for the burning of face brick and fire brick, fuel oil is employed. The brick are set in four rectangular down draft kilns, each with a holding capacity of about 160,000 brick. These kilns are arranged with a row of fire boxes down each side and doors at each end. They are arched over from side to side to form the crowns and are 16 feet across inside and 72 feet long. The crown arch starts at about 7 feet from the floors, and is 14 feet high in the middle. The fuel oil is sprayed into the kilns through atomizer burners, using steam as an atomizer. These are known as Schur's burners and are manufactured in Los Angeles, Cal., where oil burning is carried on very extensively. The oil burning system has proved to be not only cheaper per equivalent unit than coal, but the labor and trouble saving is marked, being in the ratio of about as two is to seven. In addition, the quality of heat generated by oil produces a much superior and more even colored product.

Face brick are manufactured on a four-mould dry press at the Kilgard plant with a capacity of 24,000 brick every ten hours. An average daily output of 20,000 brick is, however, considered satisfactory. The output of the plant consists of white, buff and red burning face brick, fire brick, blocks for coke ovens, and special fire clay shapes, and sewer pipe. The machinery installed at Kilgard was purchased as far as possible from Canadian manufacturers, but some of it had to be secured of necessity from the United States. All the dry and wet pans, and the four-mould brick press equipment were supplied by the Berg Machinery Company, of Toronto, Ont. The sewer pipe press, storage feeder, elevators, trucks, rockers, cradles, etc., for handling sewer pipe, were supplied by the Stevenson Company of Wellsville, Ohio. The entire plant is driven by individual motors, all of which were supplied by the Canadian Westinghouse Company, of Hamilton, Ont. The plant is equipped with the following motors: seven 50 h.p.; one 35 h.p.; one 25 h.p.; two 12 h.p.; two 10 h.p.; four 5 h.p.

Electric current is furnished by the Western Canada Power Company from their Stave Falls power plant, which is located about 20 miles north of Kilgard. The Kilgard Fire Clay Company's plant, which started operating in September, 1913, was financed by local, Vancouver and English capital, and represents an investment of approximately $300,000. The construction of the entire plant as well as the working out of the different mixtures, systems, and the commencement of actual operations, was under the supervision of Mr. F. H. Riddle, a well-known ceramic engineer, who has had considerable practical experience in the clay industries. Prior to his connection with the Kilgard Company, Mr. Riddle, for a number of years, acted in an advisory capacity with the American Sewer Pipe Company, of Akron, Ohio, where he was engaged principally in the manufacture of brick, sewer pipe and hollow wares. He has been a member of the American Ceramic Society for several years past.

Brick Pavements as an Investment*

RECENTLY I observed the revenue from two separate farms of three hundred and twenty acres each, located in the corn belt of Illinois —one at the end of a four-mile brick paved road and the other at the end of a four-mile mud road. These farms should produce under the ordinary rotation of crops annually two hundred and eighty tons of corn, eighty tons of oats, and one hundred and twenty tons of hay, or four hundred and eighty tons in the aggregate to be delivered over four miles of roadway. On the brick road there has been delivered eleven tons of grain in one trip by one team, using five wagons, while on the earth road two tons were all that could be delivered by a similar team. The haul being four miles in both cases, and as they could make three trips a day, twenty-four miles team travel, the team on the earth road could deliver six tons a day at a cost for team and wagon of $4.50, thus making a cost of 75 cents a ton for the four-mile haul. On the brick road the delivery was 33 tons a day at a cost of 19.7 cents a ton on a four-mile haul—a difference of 55 cents a ton in the cost of delivery in favor of the brick road, or a difference in cost of $264 on the 480 tons delivered. This is only a small per cent. of the actual loss to the farmer living on the earth road, as he has had to sell his grain at a time when the roads were in condition that it could be delivered without regard to the price of his product. From actual experience it has been demonstrated that this would represent a loss of $1.50 a ton on corn, $2.50 a ton on oats, and $5.00 a ton on hay, making a loss in the aggregate of $920 on account of not being able to deliver at the best market price. This with the loss in cost of delivering makes $1,184, or 10 per cent. on an investment of $11,840, an increase in value of $36 an acre on his 320-acre farm. This represents the investment in a nine foot brick highway that has cost the tax payers of the township $10,000 a mile; or if all of the principal highways of the township could be improved, would only represent a tax on all of the property, or $10 an acre. These brick roads are not a liability; they are an asset. They don't cost you money —they make you money. It isn't a question of whether you can afford brick roads—the question is, how can you get money enough together to do without them. Bad roads are expensive. The most expensive road is the one you cannot use.

The cost of a brick road ten feet in width at $1,100 per foot in width per mile as compared with the roads being built of other materials at a cost of $550 per foot in width per mile at the end of a twenty-year period has been demonstrated to be less expensive after adding to the original cost in each instance five per cent. on original cost together with the maintenance in either case for the twenty-year period. This does not take into account the expense and inconvenience due to the repairs and re-surfacing of the cheaper roadway, nor does it give credit to the brick road for being in a serviceable condition at all times for the twenty-year period. Many brick streets that have withstood the the traffic and the effect of the elements for more than twenty years are in perfect condition to-day.

---

*Extract of paper by W. T. Blackburn, Paris, Ill.

It has been said by a prominent authority that "the life of a well-constructed brick pavement cannot be estimated with any great degree of exactness: first, because the traffic conditions are constantly changing; and second because no brick pavement which has been constructed in accordance with the best modern practice has yet worn out. The amount of wear sustained by given pavements during comparatively long periods of years has been determined in several instances, but periods of years has been determined in several instances, but has usually been so small as to make the probable term of service appear almost indefinite."

From such evidence we may conclude that the properly-constructed brick road is entitled to a life of twenty years without repair, or a period long enough to allow us to forget that the original construction ever cost anything. The original cost is as far as many of us can see. Benefits are too seldom looked into. We are inclined to complain of taxation as a burden instead of a blessing and the real foundation of our civilization. The greatest assets of the most substantial nature are transportation and agriculture. Neither can be fully developed without the other.

The total tonnage drawn over the highway at this time may be quite small, but upon the improvement and development of the road and the resources of the country, the tonnage may be increased many tons. While the requirements of to-day may be only ten to twenty tons, these improved conditions have caused this road to become a main highway, with from two hundred to three hundred vehicles a day, many of them three to six-ton trucks. Not only should the improvement be made to care for the present traffic, but to provide for a far greater traffic, not only in the number of vehicles but in their character. The traffic which was once only local, confined to teams from a few of the neighboring towns and villages, has become inter-state, and almost national in character.

Such roadways should have a firm unyielding foundation. The drains should be brick so that the water will not remain in side ditches or be held in the sub-soil higher than within eighteen inches of the wearing surface. Upon the foundation it has been found necessary to provide a sand-cushion of sufficient depth to compensate for the irregularities in the base and the difference in the depth of the units used in the wearing surface. This cushion may be of a specified depth from one to two inches, preferably not more than one and one-half inches. The most important feature is that this sand-cushion should be made firm and evenly compacted, that the bricks may rest thereon without imbedding them, as the space between the bricks should be left open to receive the bonding material. The specifications should make provision for the character of sand to be used and the proper preparation of the sand bed. The material for the wearing surface should be of such a character as to withstand the action of the elements for all time. The material should be of such character and should be placed in the roadway in such a manner as to offer the least resistance to travel. The surface should be made smooth, and so bonded together as to become monolithic. Proper specifications should provide that the bonding material should surround every unit, and that this bond should be of a permanent and enduring character.

These highways should be so improved that they will require the minimum of maintenance and last in a serviceable condition longer than the life of the bond issue created to provide for their investment.

A portable crane-controlling device which is in use at the docks of the Manchester Ship Canal Company, at Manchester, Eng., enables a cargo-handling crane to be controlled by an operator standing near the work instead of riding on the crane. The controller weighs about 7 lb. and is hung from the operator's shoulders; two handles govern the lifting, lowering and swinging movement. From the controller switch an armored cable leads to the crane ring and to a set of small collector rings, the motors being operated through a system of controllers. By means of this appliance the discharge and loading of ship's cargo can be performed more rapidly and safely than under the ordinary system. The crane operator can stand at the ship hatchway, more about freely and keep in sight and control of the load from the time it leaves the bottom of the hold.

Buoys of reinforced concrete built for Kingston, Jamaica, weigh each about 5 tons, carry about one ton of ballast, and are said to cost a little less than half as much as steel buoys of the same size. The buoys are cylindrical in shape, with the bottom concaved to give protection to the mooring chain eye bolt. The sides have curved horizontal ribs, with bottom reinforced bars built up inside the shell, and waterproof cement on the outside and inside builds up the total thickness of the sides to 3 inches. The top is a solid slab, with reinforcement extended down the side. A temporary manhole serves for removing the interior centering and for convenience in lowering; but its cover is sealed in place when the work is finished. As water sometimes leaks in during the first few days a buoy is in use, a pump hole with brass screw cap is provided.

Mining material for the manufacture of lime from the bottom of the sea is one of the unique sights on the island of Martinique, French West Indies. The bulk of the lime used on the island is manufactured from madreporic stone, or reef coral so mined. It is of good quality when made with care. Procuring the material for making lime would appear to be a most hazardous employment. The reefs from which the coral rock is taken are in the bay, fully a mile from shore. Small dugouts are floated over the reef and the coral brought up from the bottom by hooks or grapnels attached to poles 12 to 14 feet long. The boats are loaded until but a few inches of the sides are above water. It requires both skill and experience to load the boats without upsetting and to land the cargo without sinking.

LETTERS

Concerning Architectural Competitions

Montreal, April 8, 1914.

Editor Contract Record:

Your editorial published under the above heading in your issue of March 18 raises a question which the architectural profession has been discussing for many years. It is a matter which, probably, the profession will never be able to decide satisfactorily for all its members.

In Canada we are not troubled with architectural competitions to the extent that the architects of England and the older countries are. In England it is a well known fact that for practically all work of a public nature competitive designs are invited, and it is no uncommon thing to find that one hundred, or one hundred and fifty, architects will submit designs in competition for a building that is to cost only $75,000. When one considers the enormous amount of labor and money that such a competition represents in the preparation of all these designs one cannot regard with favor such a method of selecting an architect. It is a fact that the better known and more experienced men in these older countries often refuse to enter into competition under such laborious conditions. This is not surprising, for if an architect is busily engaged in private practice he will not want to spend his time in "taking chances," unless the bait be particularly tempting.

In the case of the London County Council Buildings two competitions were held. In the first, hundreds of competitors entered and twelve were selected. In the second, these twelve were invited to submit new designs, together with eight experienced and well known men at the top of the profession. The eight were paid for their designs and had not been asked to compete in the first instance. The result was satisfactory to all and the winner proved to be a young man who was not in practice for himself and whose talent probably would never have been discovered had it not been for such a competition.

In another well-known case, that of Liverpool Cathedral, we find a young architect in his early twenties coming out on top and by his masterpiece, carried out in stone, fully justifying the selection of his design.

Such cases as these prove that competitions have their good points for architects who have to rely upon such methods of bringing out talent and placing them on a par with more famous and more fortunate confreres.

One of the best known and most successful architects in England of the day once stated in the presence of the writer that he had submitted as many designs as he was years old (43) before meeting with any success. This is not a solitary case. Such instances are plentiful in the older countries. We cannot but admire the dogged perseverance of such men.

In competitions it does not always appear that the design that is worked out the most conscientiously in accordance with the instructions laid down is the one placed first in the end. It is not difficult to recall cases where the successful competitor has wholly disregarded the conditions, honestly believing that by so doing he could submit a better scheme than the promoters had in mind. There have been instances of where his very boldness has appealed to the assessors and the strict interpretation of the conditions has been disregarded in his favor—it may be to the discomfiture of the other competitors.

It is very certain that as this country continues to grow and more improved buildings are contemplated competitive designs will be called for in ever-increasing number. For work of a special character, such as a hospital, theatre or hotel, the best results would seem to be obtained by commissioning an architect direct—selecting a man who makes a specialty of such a type of building. And it is not difficult to find men who concentrate their studies upon structures of special types. In monumental work, such as public buildings and public halls, however, it should be possible to obtain the best results in properly-conducted public competitions. For this reason it is of primary importance that Canadian architects as a body should agree upon certain vital principles embodied in any "Conditions of Competition" before submitting their designs. Where these principles are not agreed to by the promoters, architects will serve their interests best by refraining from taking part in the competition. This stand has been taken by the members of the Royal Institute of British Architects, and it is owing to the loyal support which the Society has received from its members that conditions of competition are generally carried out on the lines laid down by the R. I. B. A.—indeed the Institute is even consulted by public bodies and others before the conditions are advertised. Such a stand taken by such a well-known Society has done untold good to the profession and won for it well-deserved respect from the general public.

Briefly, the more important elements that are insisted upon are the following:—

1. An unbiassed professional assessor (or assessors) whose decision in the awards shall be final.
2. The paying of the successful competitor some stipulated fee for his design should the building **not** be erected after the competition.
3. Designs must not bear any name or nom de plume.
4. All drawings must be uniformly rendered and finished.
5. There must be strict adherence to the conditions of cost, etc.
6. Perspective drawings must not be submitted as a rule, such drawings not being always rendered truly.

I have submitted these few observations at your request and shall look forward to seeing further discussion of the subject in your columns.

Philip J. Turner (F.R.I.B.A.).

A Winnipeg Architect Disagrees with Competitions

Winnipeg, March 31, 1914.

Editor Contract Record:

The sentiments expressed in your editorial article, "Are Architectural Competitions in the Best Interests of the Profession?" published in your issue of March 18, are entirely in accord with my own. I have always considered competition a lottery and I do not believe that the awards go to the most capable. I should much prefer to make six sketches for a real client than to be one of six to make sketches for a prospective client. In choosing an architect a client should enquire of others who have had dealings with the profession. With their architect they should look at buildings similar to those they wish to erect. They should take the professional man on the merits of his ability, treat him confidentially and go into all the details with him.

In a competition the competing architect is practically bound to keep his design secret. If he make enquiries about the requirements from some one in charge of the competition it is not long before the identity is revealed and then the competitor is judged by his ability not as shown in the sketch but as it is held in public esteem. This, in my opinion, defeats the object of the competition. We occasionally hear of the obscure draughtsman winning a competition. I have never heard from the client after the completion of the work.

E. D. Tuttle.

Personal Mention

Mr. B. W. Folger, President of the Kingston Street Railway, passed away recently in Toronto.

Mr. John A. Wilson, city engineer of Kamloops, B.C., has resigned and has been succeeded by Mr. E. Kingwell.

Messrs. Turner & Carless, architects, have removed from the Board of Trade Building to 49 Beaver Hall Hill, Montreal.

Mr. Charles L. Smith, general manager of the Oregon Short Line Railroad, passed away last week at St. Catharines, Ont.

The Toronto Harbor Commission have removed their offices from the Bell Telephone Building to apartments in the Otis-Fensom Building, 50 Bay Street, Toronto.

Mr. C. A. P. Turner, consulting and contracting engineer of Minneapolis, Minn., has removed his office from the Phoenix Building to the new Walker-Burton Building in that city.

Mr. J. W. Battershill has been appointed engineer of the Municipality of East Kildonan. Up to the date of his appointment he had been in the City Engineer's Office, Winnipeg.

The town of Sudbury, Ont., is advertising in this issue of the Contract Record for a consulting engineer to work on a salary and percentage basis. Mr. W. J. Ross is the town clerk.

Mr. F. D. Friend, resident engineer for the National Transcontinental Railway, died recently from heart failure. The late Mr. Friend came to Canada about ten years ago from Devonshire, Eng.

Mr. Jas. M. Barker, formerly in the engineering service of the Canadian Pacific Railway as draughtsman, has been appointed Instructor in Civil Engineering at the Massachusetts Institute of Technology.

Mr. S. B. Wass, chief engineer of the Quebec Extension Railroad, is undertaking the work of assistant chief engineer of the St. John (Que.) Railway, a proposed line 174 miles long in Quebec and the State of Maine.

Mr. Wallace Broad addressed the Engineering Society of the University of New Brunswick recently on "Engineering in China." Mr. Broad, who is a graduate of N. B. University, was for a long period mining advisor to the Chinese Government and has spent considerable time in the Orient.

Mr. James Warwood, who was one of Toronto's earliest pipe and brick manufacturers, died on April 7 at Huntsville, Ont., in his seventy-seventh year. His first brick field was situated at Yorkville. He subsequently started another plant at Old Garrison Creek, which is now the Western Stock Yards.

Mr. John Barker, who had been in the employ of the City of Toronto for the last forty-seven years as diver and storekeeper for the waterworks, died on April 2 after a short illness. In early life he was engaged in railway construction work in the southern States and Mexico. As a diver he assisted to lay the first pipe across Toronto Bay.

Mr. Francis S. Cleary, whose death took place at Munrovia, Cal., on March 24, was born in Windsor, Ont., twenty-seven years ago. He was a graduate of the Faculty of Applied Science and Engineering, University of Toronto. For the past two years he had been employed as an electrical engineer with the Edison Illuminating Company, Detroit.

Mr. Walter J. Francis, C.E., Consulting Engineer of Montreal, addressed the last evening meeting for the season of the Ottawa Society of Civil Engineers on April 2, his subject being "The Engineer and the Public," in the course of which he advanced many arguments in favor of a united effort on the part of engineers to elevate the profession by a better education of the young men entering it, the maintenance of a proper standard of dignity and perfection in the engineers' work and co-operation with fellow engineers.

Dr. John Galbraith, Dean of the Faculty of Applied Science and Engineering, University of Toronto, was the guest of honor at a banquet given on March 28 by the graduates of the Faculty who are resident in Ottawa. The function, which was held at the Chateau Laurier, was attended by over eighty graduates and was the first of its kind held by the graduates in engineering of the University of Toronto who reside in Ottawa. Representatives from other centres included Major C. H. Mitchell, Consulting Engineer, Toronto; Professors Wright and Loudon, representing the Faculty of Applied Science and Engineering; Mr. J. L. Morris, C.E., and Surveyor, Pembroke, the earliest graduate of the Institution. An interesting outcome of the function was the appointing of a local committee to arrange for a permanent organization, to be known as The Ottawa branch of the Engineering Alumni Association, University of Toronto.

Mr. A. Gravel, Chairman of the Levis Board of Trade, and member of the Harbor Commission of Quebec, has received a communication from the shipbuilding firm of Sir W. Armstrong with reference to the establishment of a branch of that firm across the river in connection with the new graving dock, on which work is to commence immediately. A delegation composed of the Mayor of Levis and members of the council and board of trade have decided to interview Hon L. P. Pelletier on the occasion of his visit to Quebec, and will seek his influence in the effort to obtain a Government subsidy in aid of the projected industry.

Coming Events

The American Road Builders' Association will hold their next annual congress and exposition in the International Amphitheatre, Chicago, December 14 to 17, 1914.

The Seventeenth Annual Meeting of the American Society for Testing Materials is to be held in Atlantic City, N.J., June 30 to July 4, 1914. The Secretary is Mr. Edgar Marburg, of the University of Pennsylvania, Pa.

Good roads enthusiasts should keep their eye on the Canadian and International Good Roads Congress, which is to be held in Montreal next month (May 18-23). The secretary is Mr. G. A. McNamee, New Birks Building, Montreal.

The Seventh Annual Assembly of The Royal Architectural Institute of Canada is to be held at Quebec City, September 21st and 22nd next. The President of the Institute is Mr. J. H. G. Russell, of Winnipeg, and the Honorary Secretary, Mr. Alcide Chausse.

The Second International Congress of Consulting Engineers will be held at Bern (Switzerland) on the occasion of the Swiss National Exhibition from July 15 to July 22, 1914. The first congress of this kind was held in 1913 at Ghent, Belgium, on the occasion of the Universal Exhibition in that city. At last year's congress an International Federation of Consulting Engineers was founded with a view to unifying the various professional societies already in existence in a number of countries and to assisting in the formation of similar organizations where nohe has been established. It is desired to establish a strong bond between consulting engineers throughout the entire world, it being considered that such a bond will make for professional advancement. Those who are interested should address enquiries to M. Herbais de Thun, Secretary of the Consulting Engineers'

Congress, 18 rue Marie-Therese, Brussels, Belgium. In sending us these particulars Mr. de Thun advises us that it is proposed to hold the third International Congress at San Francisco in September, 1915.

Protecting the Canadian Stone Industry

The decision of the Government to increase the duty on dressed stone, announced by Mr. White during his budget speech, is the result of representations made by stone cutters and quarry owners throughout Canada. The Montreal Builders' Exchange have taken a foremost part in asking the Government to give increased protection to this industry, and have been represented on two deputations which have waited on the Government within the last two years. The stone cutting and quarry trade section of the Montreal Builders' Exchange in the fall of 1912 presented a very strong petition to the Minister of Finance, setting forth the need for higher duties. They then asked for a specific duty of 65 cents a cubic foot on building stone of any kind, sawn, dressed, hewn, polished, or otherwise manufactured. The Government, however, propose that the duty of 20 per cent. on dressed stone should remain on stone sawn on two sides, but if sawn on four sides it will pay 15 cents per 100 lbs.; and if turned, cut or further manufactured 45 cents per 100 pounds.

The Canadian stonecutters and quarry owners contend that there is plenty of suitable stone in the Dominion for all purposes, if the industry were given proper protection, although architects who specify Indiana limestone and Ohio sandstone state they do so for the reason it is most suitable for their purposes. The present duty is levied on the quarry value of the stone, which in effect makes the duty lower than 20 per cent., and the Canadian trade also complain of discrimination in the matter of railway rates by the American companies. If American stone be imported into Canada, it should be in the rough, so that the labour required to manufacture it would be Canadian. It is urged that higher duties will help to build up a big industry which will be able to give sure and prompt delivery, but until there is a certainty that no dumping will be allowed further capital will not be invested so as to give this positive delivery. The higher duties will be of value to the stone cutters, but apparently do little to protect the quarry owners, as the duty on rough stone remains at 15 per cent.

The business of the MacKay, Paulin Construction Company, Limited, is now being carried on by the Canadian Engineering and Contracting Company, Limited. The personnel of the company remains the same with Mr. James J. MacKay, president, Mr. F. W. Paulin, vice-president and manager, and Mr. F. A. Magee, secretary-treasurer. The new company will carry out all the contracts and engagements of the old firm.

Bulletin B3 of the Herbert Morris Crane & Hoist Company, Limited, Toronto, comprises an illustrated description of the various types of the Morris travelling spur-gear chain-block. This chain-block effects remarkable economy in the saving of time and labor. The various forms in which it is made and its snug construction attest the thoroughness with which the Morris firm specialize in lifting machinery. A high speed of lifting is obtained by using a small gear ratio, which is only rendered possible by the extreme accuracy of the work which is put into the cutting of the gears and the setting out of the steel side plates. The Herbert Morris firm also manufacture worm-gear, triple-gear, chain-blocks, jib-cranes, overhead cranes and overhead runways.

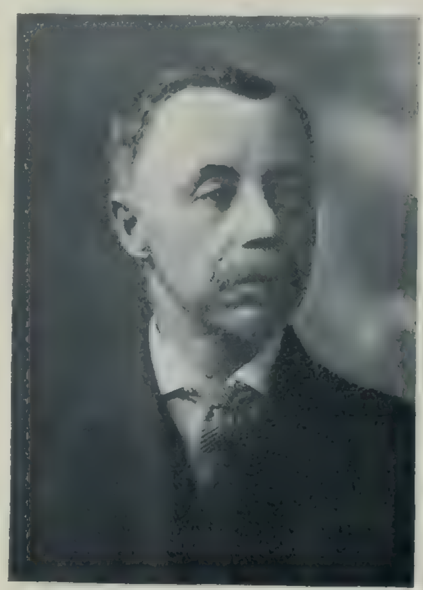
Dredging in Courtenay Bay is now proceeding, and quite a basin has been dug out. It is stated that two more dredges are on the way to St. John to assist in the work.

Canadian City Engineers

Mr. George Smith, Town Engineer, Midland, Ont.

The Town Engineer of Midland, Ont., Mr. George Smith, is the senior member of the firm of Messrs. Smith & Smith, civil engineers and land surveyors, of Lindsay, Ont. He began his professional career in 1881 as an Ontario Land Surveyor and at the outset was engaged in what is known among the surveying profession as detective work, that is, in retracing obliterated government survey lines, some of which were from eighty to one hundred years old. In the winter of 1905 and 1906, when the Toronto-Sudbury line of the C. N. R. was being built through a country of burnt desolation and the work of establishing the greater number of the lot and concession lines required to be done on their plans baffled the company's best surveyors, every lot and concession line, from the Severn River to Parry Sound and on to the Key Inlet, a distance of over seventy-five miles, was located by Mr. Smith.

In addition to such survey work, Mr. Smith has had extended experience as a valuator in railway arbitration cases.



Town Engineer Smith, Midland, Ont.

His greatest field of activity, however, has been municipal, his work for various councils having extended over thirty-five years, twenty-five of which have been partly taken up with drainage work, under the Drainage Acts, and road construction, including bridge work in the County of Victoria, where he has introduced the concrete beam span slab top bridge, a form of structure which is built in spans of from twenty to forty feet. Last season he engineered the construction of a bridge of his own design across a lake narrows of some three hundred feet, in which five of such 20-foot spans, on top of a riprap fill fourteen feet deep were constructed with satisfactory results. He has built a number of steel and concrete bridges in spans ranging from thirty to eighty feet, and in one case where over four hundred feet had to be spanned he used two eighty feet spans on concrete piers, with approaches of two hundred and fifty feet of neatly sloped and faced dry wall fill on riprap foundation, the whole work costing nearly $10,000.

The town engineership of Midland was accepted by him early in 1913, the council contemplating the installation of a sewage disposal plant and the carrying out of extensive street improvements.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The McLean Construction Company, Limited, has been incorporated at Toronto with a capital of $500,000.

Port Arthur's building permits for March, 1914, amount in value to $266,488. The largest permit for March was $220,000 for a new customs building.

Messrs. Gauthier & Daoust, of Montreal, are the architects for a new apartment house to be built at Outremont at a cost of $200,000. Tenders are now being received.

Mr. H. C. Mott, St. John, N.B., is preparing plans for a new hospital building to be erected in that city at a cost of $300,000. The city council has been authorized to issue bonds to raise the necessary money for the work.

Port Colborne, Ont., ratepayers will shortly be asked to vote on a bylaw as to giving a fixed assessment and certain other privileges to the Niagara Grain & Feed Company, Limited, who contemplate the erection of the plant at a cost of $200,000.

Mr. Geo. Heidman, building inspector, stated recently that the building season at Stratford, Ont., would probably be one of the best on record. The principal buildings to be constructed include the new Knox Church, new factories and the new Avon school.

The city of Quebec has been authorized to raise the sum of $625,000 for municipal improvements upon which tenders will be called shortly. The details, as given, are as follows: ornamental posts, $125,000; improvements in Limoilou Ward, $100,000; improvements in Belvedere Ward, $250,000; exhibition improvements, $100,000.

The value of building permits issued in St. John in March was $73,500. Several companies are preparing plans for groups of houses to be erected in the outskirts of the city this year, and there will be general activity throughout the summer in building operations.

Not only the company which has the contract for the timber substructure of the new wharves at West St. John, but the company which will construct the concrete face and surface, are assembling their plant and during the spring and summer will have large crews at work night and day.

The City of Toronto has obtained the right from the Ontario legislature to run three roads through Prospect cemetery. One is a continuation of Ascot Avenue, another a continuation of Summit Avenue, while the third is a new thoroughfare to be opened up between Tinmouth and Morrison Avenues.

The Imperial Bank is about to erect a seven-storey branch office at the south-east corner of Yonge and Queen streets, Toronto. It will be of steel construction, fireproofed, and will cost about $200,000. The base will be of granite and the upper storeys of terra cotta. The structure will have a 31-ft. frontage on Yonge street and a depth of 110 ft. along Queen street.

Sir Robert Perks, head of the well-known contracting and engineering firm bearing his name, who is at present in Canada in connection with business matters, declares that it would be waste of public money to deepen the St. Lawrence as an alternative to the proposed Georgian Bay canal. He estimated that the Welland-St. Lawrence project would cost $280,000,000, or double the cost of the Georgian Bay scheme.

The newly constituted Civic Housing Committee of Toronto has recommended to the City Council a comprehensive competition for plans for the proposed model houses with a view to proving in a practical way that artisans' dwellings can be built at a reasonable price within easy reach of the street railways. The designs submitted must comply with the building bylaw and prizes will be given for the best plans sent in.

Hon. Robert Rogers, Minister of Public Works, assured a large deputation from Charlotte County recently that the development of the St. Croix harbor would receive the first consideration of the government when the estimates were brought down, probably next fall. Mr. Rogers emphasized the desire of the government to develop national harbors to encourage as far as was within their power the shipment of Canadian products through Canadian ports.

Work will commence in a few weeks on the erection of a new General Hospital for Walkerville, Ont. The building will be 128 feet by 44 feet and is estimated to cost $75,000. The foundation will be of concrete, with rubble stone facings for the first floor, and red brick above. All the windows will be rusticated stone, while the entrances will be of carved stone, classic design. The whole building will be of fireproof construction. Messrs. Smith & Walker, of Walkerville, are the architects.

The programme of the Highways Commission was laid on the table of the Ontario Legislature a few days ago. The report outlines a plan by which the entire road system of Old Ontario will be completely reorganized and brought under a new treatment designed to make the province a standard for efficient traffic roads on the continent. The outstanding proposal is an expenditure of $30,000,000 on Ontario market and trunk roads in the next fifteen years. The money is to be contributed by province, counties and cities, and also by a tax on motors.

A company to be known as the Dominion Engineering and Machinery Company is to be formed with a Dominion charter to take over the old and well-known Toronto concern, the Ontario Wind Engineer and Pump Company, Limited, which has been in business in Toronto since 1894. The new company will be capitalized at $2,000,000 in equal amounts of cumulative, preference and common stock. The company manufacture agricultural engines and machinery, pumps, windmills, gasoline engines, etc. The new capital will allow extensions of business and will incidentally repay bank advances.

Estimates have been prepared for road improvements to be undertaken this season in Northern Ontario. Details are as follows: Rainy River, $85,000; Kenora, $35,000; Port Arthur, $60,000; Fort William, $90,000; Sudbury, $50,000; Sudbury Soo Trunk Line, $90,000; Sudbury North Bay Trunk Road, $50,000; North Bay Mattawa Trunk Line, $50,000; Haileybury and South Lorraine, $15,000; Elk Lake District, $20,000; South Porcupine, $20,000; Charlton Colonization

Road, $35,000; Road along T. & N. O., $120,000; Road along N. T. R., $105,000; Mattawa to Pembroke, $15,000; Larder Lake Mining Road, $5,000.

Mr. M. J. Butler, consulting engineer of Messrs. Armstrong-Whitworth Company of Canada, has returned from a business trip to England. Mr. Butler announced the other day that the plant at Longueuil will commence operations by September 1. For the first few months the steel will be brought from England in the unfinished state, but in about a year from now the entire process of manufacture from the smelting of the ore upwards will probably be carried out in Canada. He announces that in all probability a Canadian Company will be formed for the manufacture of ergite, the new explosive, the merits of which he enquired into while in England. This explosive is said to be particularly satisfactory as regards transportation, because it comes in two parts, both inert and harmless until mixed.

WESTERN CANADA

At Prince Rupert a court house is to be erected at a cost of $150,000. The architect is Mr. A. A. Cox, Carter-Cotton Building, Vancouver.

A new Presbyterian church has just been opened at Moose Jaw, Sask. The structure, which has a seating capacity of 1,400, entailed an outlay of $190,000.

At Edmonton, Alta., operations are about to commence on the new R. C. Cathedral for which Mr. R. W. Lines, of Edmonton, is the architect. The expenditure involved is $300,000.

During the past year five government wharves have been constructed on the Fraser and Pitt rivers, involving an outlay of between $12,000 and $15,000. The last of the five has just been completed.

Mr. George Aylesworth, of Edmonton, and Mr. Ernest L. Shipman, of New York, will build and equip a moving picture plant, costing $150,000, in Edmonton this year. Work is to begin in June.

At Calgary, Alta., tenders are being received by the architect, Mr. A. Pirie, on an Industrial Housing building, seven storeys high, of reinforced concrete construction, estimated to cost $200,000.

The Board of Governors of Saskatchewan University are receiving tenders for students' residences at Saskatoon estimated to cost $250,000. Messrs. Brown & Vallance, of Montreal, are the architects. Bids close April 20.

Mr. George P. Robson announces that a syndicate of Edmonton capitalists which recently paid $100,000 for a double corner site at Ninth Street and Jasper Avenue, will erect a large business building there this summer.

Good progress is being made with the work of erecting additions to the legislative buildings at Victoria, B.C., and it is expected that the entire new block will be ready for occupation by the various departments next September.

Forty thousand dollars is the estimated cost of a three-storey business and office building, 50 by 100 feet, to be erected this season for Dr. F. N. Condell at Ninth street and Jasper avenue, Edmonton. Mr. J. H. Gariepy will also expend $50,000 in a three-storey building.

Western Apartments, Limited, is completing a three-storey structure of brick and steel, known as the Allan block. There are four store rooms on the ground floor and forty-two offices and apartments on the upper storeys. Mr. R. Armstrong is manager of the building.

At a meeting of the board of governors of the University of Saskatchewan recently, plans for a new students residence to be added this year to the group of buildings already on the campus, were considered and tenders will be received by the board up to April 20. Messrs. Brown & Vallance, of Montreal, are the architects.

Operations have been renewed on the Normal School which is being erected at Camrose, Alta., at a cost of $250,000. The work is under the supervision of the Provincial Architect, Mr. R. P. Blakey, of Edmonton. The general contractors are Messrs. Read, MacDonald & Brewster.

Edmonton Metal Works, Limited, a branch of the Winnipeg Ceiling Company, which is in turn a branch of the Duluth Corrugated Company, is erecting a factory building, 75 by 125 feet, costing $25,000, near the exhibition grounds in Edmonton. Mr. W. J. Magrath is manager of the plant, which will be equipped with modern machinery.

Mr. Harry V. Shaw, proprietor of the Edmonton cigar factory, will erect this year a four-storey warehouse and factory building, 50 by 130 feet, at a cost of approximately $65,000, for which plans have been drawn by Messrs. Magoon & MacDonald, architects. The entire top floor will be laid with white tile, and the walls treated with waterproof cement. Sawtooth skylight will give a northern light.

Ninety-eight thousand dollars is the estimated cost of a four-storey office and store building, to be erected for Williamson Brothers at Jasper and Fraser avenues, Edmonton. Messrs. Nesbitt & Miller are the contractors, the architect being Mr. E. W. Morehouse. The building will be of fireproof construction throughout, a feature being the front of ivory terra cotta. It is to be completed October 1.

Official announcement is made that the Swift Canadian Company will erect an addition of three storeys, 64 by 80 feet, at its plant at North Edmonton. The structures will be of brick and reinforced steel. The first floor will be used as a carpenter shop, machine shop, blacksmith shop and tin shop. The second and third floors will provide additional storage capacity for the products of the packing plant.

Arrangements have been completed by the city of Edmonton to erect cattle and sheep buildings, an addition to the Manufacturers' building and a new heating plant, costing $87,840, at the exhibition grounds this season. The municipality also has plans for a filtering plant, to cost $117,000. The Consolidated Jewell Filtration Company of New York will do the work.

Messrs. Magoon & MacDonald are preparing plans for a building for the Young Men's Christian Association of Edmonton. When completed the building will have cost $500,000. The structure will be eight storeys in height. There will be a gymnasium 50 by 100 feet, a swimming pool, 22 by 73 feet, and more than 200 rooms, in addition to offices, billiard, reading and class rooms.

Large numbers of contractors from Eastern Canada, the United States and Great Britain have tendered for the construction of the proposed bridge across the Second Narrows, the work to cover foundations, superstructure and completion of the bridge. Separate tenders are invited for the substructure and the main structure. A number of British Columbia contracting firms have also tendered for the work.

Mr. Roland W. Lines, architect, is preparing plans for a cathedral, to cost $250,000, for the English-speaking Catholics of Edmonton. The site selected is near the University of Alberta. The structure will be of Moorish design. In addition the church will erect a palace for Bishop Legal, a large cement building, a power house and residence for the laborers. All the buildings will be of concrete, steel and tile.

In the City of Regina, Sask., during March 80 permits were issued for buildings at an approximate value of $90,000. For the corresponding month of 1913 permits were issued to the value of $440,845. The total value of permits up to March 31 was $156,750, against $693,495 for the corresponding period of 1913. These figures, issued from the office of the Building

Inspector, Mr. O. E. Falls, indicate that so far this year building activity in that portion of the west is somewhat below the average.

Two hundred and twenty-one building permits, involving an aggregate expenditure of $383,350, were issued during March in Edmonton. Mr. N. A. McIvor, building inspector, says in a report that this season promises to be characterized by the erection of more substantial structures than in the past, adding: "Better construction in blocks, as well as in residences, is looked forward to, and buildings will have more convenience and will be more in conformity with recognized housing codes."

City Commissioner Yorath proposes that Saskatoon should take the initiative in urging the Provincial Government to adopt a town planning act. In the opinion of Commissioner Yorath, a town planning act should provide for: (a) the design of a proper system of main sewers, water mains and tramways; (b) the types of main, secondary and residential roads; (c) the provision of open spaces, parks and recreation grounds; (d) the space about buildings, their limitations, height and character; (e) the restriction of stores, factories and works to special areas; (f) amenity; (g) compensation and betterment. It is likely that the Council will act in the matter.

The new one-million-dollar station and office building at Vancouver will be ready for occupation in June. The building is of steel frame construction, six storeys high, with a frontage of imposing architectural design with rows of massive Corinthian pillars standing out from a brick background with stone cornice. A four-track passenger platform, 1,000 feet long, is being provided. The C. P. R. has other large schemes in the capital of the province amongst which are important terminal plans, including viaducts and a dock 150 feet wide, to accommodate C. P. R. steamers on the coast service. The dock scheme embraces a water frontage of nearly a mile.

Building in Vancouver so far this year appears to be on the down grade judging from the report of Mr. S. N. Janett, Building Inspector, for March, 1914. From this we learn that for the month under notice the total number of permits issued was 178, and the value of the buildings $568,845 against 244 permits and $1,091,115 in value of buildings for the corresponding month last year. Taking the three months we find the comparison even more marked. The permits issued for the first three months of the present year total 417 against 584 at the corresponding date last year. The value of buildings for the same period this year is $1,042,428 as compared with $4,076,663 in the three months of 1913.

The International Joint Commission at its meeting in Washington, on Tuesday, April 7, resumed consideration of the application of the Michigan Northern Power Company and the Algoma Steel Corporation for authority to divert water to build compensating works in the St. Marys River at Sault Ste. Marie. It will be remembered that the commission had these questions under consideration at its meeting in Detroit last March and had representations made on behalf of the cities of Duluth, Fort William and Port Arthur and other interests on the western end of Lake Superior. It was decided to postpone the final hearing of the application until the regular Washington meeting. Meanwhile a committee representing the Canadian and the United States governments, and of the two applicant companies, have been engaged in drafting for the consideration of the commission at Washington a set of conditions designed to combine such regulation of the dam in the St. Marys River as will effectually safeguard the interests of the municipalities and others at the western end of Lake Superior.

While in the opinion of many civil engineers and others who have explored the country lying between North Vancouver and Squamish the construction of a scenic highway from Capilano to the head of Howe Sound is quite practicable, the majority of those acquainted with the region incline to the view that a more favorable route could be found via Seymour Creek. From a construction point of view the most difficult section lies between the south valley and Britannia. It is suggested that a road could be built around the "big bluff" on the north side of the valley close to where it runs off into Howe Sound at a height of 700 feet from sea level. Mr. H. M. Burwell, of Messrs. Hermon & Burwell, formerly consulting engineer for the city of Vancouver waterworks system, expressed the opinion that a fine scenic highway could be built through to Squamish without much difficulty by following Seymour Creek. The fact that at one time the Pacific Eastern Railway was considering the location of a line from Squamish vía Seymour is pointed out as a good argument in favor of the alternative route for a road from North Vancouver.

Canadian Railroad Development

On April 1 the Canadian Northern Railway took over from the contractors 78½ miles of new trackage from Avonlea to Gravelbourg, Sask. It is expected that the line will eventually be extended to Swift Current.

Construction work will be started this season on the Canadian Northern Western line from Oliver to St. Paul de Netis, 100 miles, northeast of Edmonton, for which the bonds are guaranteed by the Provincial Government to the extent of $13,000 a mile. The route is through a thickly-settled agricultural district.

As illustrative of the growth of railway enterprise in the Dominion it will be interesting to mention that there are 7,000 miles of railway sidings in Canada. The Canadian Pacific Railway owns over 300 miles of sidings at Winnipeg, while at Montreal it has probably 300 more. In 1907 there were only 22,453 miles of railway in the Dominion. Today there are 30,000 miles.

The Toronto Terminal Company has approved plans for the Toronto Union Station and Viaduct, and has decided to ask the Secretary of State for permission to increase its borrowing powers from $10,000,000 to $12,000,000, the estimated cost of the work. The Terminal Company have also arranged for a meeting of the Dominion Railway Board in Toronto, when the Board and the City will give final assent to the plans.

The city of Maisonneuve, Que., is opposing the action of the Canadian Pacific Railway in attempting to lay their tracks on the street levels for which they had obtained permission by the Railway Commission. At a council meeting recently Mr. Michaud recalled that when Maisonneuve appealed from the decision of the Railway Commission its action had been endorsed by several large municipalities in the Dominion, including Quebec, Ottawa, Toronto, London, Winnipeg, Edmonton and Vancouver, all of which opposed level crossings.

The culvert on the new Lake Shore line of the Canadian Pacific Railway, about ten miles from Toronto, collapsed a few days ago, owing to undermining by the spring floods. A work train which was running over the culvert at the time was hurled with the tender to the bottom of a 10-foot ravine, the engineer and fireman being killed. At the time the train, which was the first to pass over the newly-constructed road this year, was running slowly, and when the engine reached the centre of the viaduct the structure collapsed. The construction of the Lake Shore line was completed last autumn.

The ability to overcome obstacles in engineering construction is nowhere better illustrated than on the section of the Grand Trunk Pacific along the banks of the Skeena river. The latter is to be one of the sights on the Grand Trunk Pacific route to Prince Rupert. The bed of the river is strewn with gigantic rocks, boulders and sand bars, and these are shifting continually under the force of the river current. By heavy expenditure of money on river appliances the railroad builders made the Skeena river serve as a means of transportation of supplies for a constructional army totalling nearly 3,000 men. Little tunnelling has been done. Nearly 4,000,000 cu. yds. of rock have been excavated on 186 miles of line between Prince Rupert and Hazelton to effect a route through the cascades.

The last mile of steel linking up the entire system of the Grand Trunk Pacific Railway was laid at Nechako River Crossing, B.C., on April 7, in the presence of Mr. Morley Donaldson, vice-president and general manager of the company. The final span of rail was spiked to the ties at 12.45 o'clock, when the road was then declared finished. At a point 371 miles east of Prince Rupert and 1,375 miles west of Winnipeg, in the heart of the rough British Columbia country, the connecting link forming another great transcontinental railway was made. In constructing the road it was necessary to erect 65 steel bridges, which were all built from Government specifications and which if joined together would stretch for five and a half miles. Three of the largest bridges are over 1,000 feet in length.

Montreal Road Congress

The first annual Canadian and International Good Roads Congress, to be held in the Arena, Montreal, from May 18 to 23, promises to be a success. In every part of the Dominion millions of dollars are being expended on the construction of new highways, and the promoters of the Congress believe that a co-operative educational campaign will conduce to economical construction, cheaper maintenance, and more satisfactory results generally. There is great need of a more uniform system of road-building and of wider knowledge on this phase of municipal work.

The Congress has been endorsed by the Canadian Highways Association, Canadian Automoblie Federation, and Canadian Manufacturers' Association, and also has the support of the Ontario and Quebec Provincial Governments. Sir Francois Langlier, Lieutenant-Governor of Quebec, will open the Congress, and will be supported by Mr. W. A. McLean, Highways Commissioner for Ontario and president of the American Road-builders' Association.

On the opening day there will be a reception of guests, the second and third days will be devoted to reading of papers, with a banquet on the evening of the second day; the fourth day will be given over to the Canadian Automobile Federation, and the fifth day will be taken up with visits to various highways in the neighborhood. In the evenings there will be lectures illustrated by moving pictures showing the construction of roads and the use of machinery. The papers will deal with practically every branch of road work, particular attention being given to construction, maintenance, various types of roads, materials, and machinery. The speakers will include Mr. A. H. Blanchard, Professor of Highway Engineering, Columbia University; Mr. W. W. Crosby, consulting engineer Baltimore State Commission; Mr. A. T. Lang, professor of applied science and engineering, Toronto University; Mr. W. H. Campbell, chief of the department of public works, Philadelphia; Mr. Paul de Sargent, chief engineer, State Highway Commission, Augusta; and Lieut.-Col. W. N. Thornton, president of the Ontario Assoeiated Board of Trade, Belleville.

Invitations are being sent to 30,000 different people, and it is hoped that many highway officials from all parts of Canada will be present.

In the exhibition section, a large number of Canadian, American and English firms will be represented, the exhibits comprising road materials and road machinery of every description.

Publications Received

Steel Bridge Designing, by Mr. B. Wells, Professor of Structural Engineering, Armour Institute of Technology. The Myron C. Clark Publishing Company, Chicago. Price $2.50 net.

Among the readers of this journal this book will commend itself to those engaged in the drafting rooms of colleges and bridge offices. Chapters are devoted to the following subjects:—Engineers' Work and Contracts; Bridge Manufacture; Rivets; The Design of a Roof Truss; Types and Details of Highway Bridges; Design of a Rivetted Truss Highway Bridge; Types and Details of Railway Bridges; Design of a Plate Girder Railroad Bridge; Design of a Rivetted Truss Railroad Bridge; A Pin-Connected Bridge; Shop Drawings; Strength of Materials.

A large number of shop and general drawings arranged in such form as to facilitate ready reference enhance the value of this volume.

Inspection of Concrete Construction, by Jerome Cochran, published by The Myron C. Clark Publishing Company, 608 South Dearborn Street, Chicago. Price $4.00 net.

This book is based upon a series of articles contributed by Mr. Cochran to Engineering and Contracting. Briefly it covers all the principal points upon which information may be desired by an inspector of concrete construction. Some idea of the scope of the contents may be gathered from an enumeration of the chapter headings:—Chapter I, Inspection of Hydraulic Cement; Chapter II., Inspection of Sand, Stone, etc.; Chapter III., Inspection of Proportioning and Mixing; Chapter IV., Inspection of Forms, Molds, Centering, etc.; Chapter V., Inspection of Steel Reinforcement; Chapter VI., Inspection of Concreting; Chapter VII., Inspection of Surface Finishes; Chapter VIII., Inspection of Waterproofing; Chapter IX., Inspection of Sidewalks, Curbs and Pavements; Chapter X., Inspection of Ornamental Work, Blocks, etc.; Chapter XI., Inspection of Molding and Driving Concrete Piles; Definition of Terms, List of Authorities, Index.

An interesting, well-illustrated pamphlet describes the Austin Improved Cube Special Street Mixer, manufactured by the Municipal Engineering and Constructing Company, for whom Messrs. Lecky & Collis, Limited, 43 Scott Street, Toronto (also 49 Beaver Hall Hill, Montreal, and Napanee Ont.), are the Canadian agents. Austin Special Concrete Mixers for laying concrete pavement or sub-base for pavement are made in two sizes, the one-third yard holding a one-bag mix and the one-half yard holding a two-bag mix. The entire outfit, including engine and boiler, is mounted on heavy steel trucks, with or without distributing boom (20 feet long) The boom will swing at a radius of 80 degrees each way, so that the concrete can be distributed on the street as desired, up to 40 feet width. The machine is equipped with a self-propelling device, arranged to run either backward or forward, and is under perfect control of the operator, who handles the machine with a steering wheel. The bucket, or skip, drops close to the ground, so that the material, which has previously been distributed along the street, can be loaded directly into the charging hopper from wheelbarrows. The steam rig requires two men to operate—one to handle the charging hopper and the other the discharging. The machine is set up from the ground so that carts can be backed directly under the discharge spout, when it is not desirable to use the boom. It will travel from one piece of work to another at the rate of one and one-half miles per hour.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Amherst, N.S.

The laying of sewers, at an estimated cost of $20,000 is proposed by the town council.

Brantford, Ont.

Tenders will be received by the Sec.-treas., F. W. Frank, until 8 p.m., April 30th, for the following: (B) fireproof pump house; (G) pumping machinery; (A) two four million gallon turbine pumps and two motors to operate same for domestic service. (B) two four million gallon booster pumps for fire service, motor driven; (C) Steam turbine alternative for operating booster pumps. Bulk tenders accepted for "B" and "G." Plans and specifications at the City Hall, Brantford, or at the office of the Engineers, Chipman & Power, 204 Mail Building, Toronto.

Calgary, Alta.

A by-law is to be submitted to the ratepayers on May 7th, authorizing the expenditure of $100,000 for the supply of material and the complete construction of a main sewer in Ogden subdivision. At the same time the ratepayers will be asked to authorize the expenditure of $50,000 on improvements to parks, and $60,000 on extensions to the waterworks system.

Estevan, Sask.

Tenders will be received by the Sec.-Treas., P. J. Stephens, until 8 p.m. May 9th, for (a) laying approximately 10,500 ft. of watermains and 16,000 ft. sewer pipe; (d) furnishing cast iron water pipes and specials; (e) furnishing fire hydrants and gate valves; (f) furnishing sewer pipe and junctions. Plans are at the Town Engineer's office, Estevan, and at the office of the Can. Engineer, Winnipeg.

South Edmonton, Alta.

The Commrs. have adopted the City Engineers report and will build a pumping station at a cost of $50,000.

Harwich Twp., Ont.

If the drainage plans about to be submitted to the Twp. Council are adopted a $60,000 bridge for the Pere Marquette Rly. will be built, and 1,500 acres of marshland drained for which a pumping station, etc., will be required.

London, Ont.

Tenders for sewer construction advertised Contract Record April 8, page 81, close May 7 and not May 17 as stated. Wm. N. Ashplant, City Engineer.

Tenders will be received by the City Clerk until April 20th, for power drill, street sweeper, 3 automatic dump waggons, street cleaning machine, and supplies, including picks, shovels, barrows, etc.

Montreal, Que.

F. J. Jago & Co., 10 Victoria St., who have the general contract for the filtration plant invite sub-tenders on roofing, ornamental iron and plumbing.

New Glasgow, N.S.

The construction of sewerage system, at a cost of $25,000 is contemplated by the town council.

The expenditure of $6,000 on road machinery is being considered by the town council.

Quebec, Que.

The city has appropriated the sum of $625,000, which is to be expended as follows:—$125,000 for ornamental posts; $100,000 for improvements in Limoilou Ward; $250,000 for improvements in Belvedere Ward; and $100,000 for Exhibition improvements. Tenders on this work will be called very shortly.

Tenders will be received by Hon. J. A. Tessier, Prov. Govt. Dept. of Highways, until April 24th, for the construction of the Sherbrooke-Derby route highway. Plans and specifications are at the Department.

Regina, Sask.

Tenders are about to be called for the following waterworks supplies: (B) cast iron pipe and specials; (C) lead pipe, galvanized iron pipe, jute rope, black pipe, pig lead; (D) iron body gate valves (Kelfie brand) valve boxes, fire hydrants, brass gate valves; (E) Corporation and curb cocks lead to leal unions, curb boxes. Engineer, J. M. McKay, Supt. of Waterworks.

Stratford, Ont.

The Engineer, A. B. Manson, will receive tenders until 5 p.m., April 25th, for the construction of 1650 ft. 5½-ft. concrete storm sewer arch and 2,940 ft. 2-ft. vitrified glazed pipe sanitary sewer on Erie street.

Plans have been drawn for improvements to the sewage disposal plant. Plans and specifications are at the office of the engineer-in-charge, A. B. Manson, City Hall, they include grit chamber, sedimentation tank, auxiliary gas engine (probably) and chlorination devise.

Sandwich, Ont.

Tenders will be received by the Clerk, E. R. North, until April 20th, for the construction of sewers, watermains and reinforced concrete pavement on Sunset avenue.

St. Catharines, Ont.

It is understood that a liquid chlorinating plant will be installed at once by the city council. Engineer, W. P. Near.

Toronto, Ont.

Plans have been prepared for a combined system of sanitary and storm overflow sewerage system for North Toronto. The disposal plant to be located in Don Valley, will consist of detritus tanks, Imhoff tanks, chlorinating device, sludge-drying beds and sprinkling filters. Estimated cost $4,144,256.

The following work has been recommended by the Commissioner of Works, R. C. Harris: Grading on Morton Road, Particia Drive, Iona, Oakcrest, Patterson, Claude and Merrick streets, Glendale avenue and Keystone Drive. Estimated cost $28,750. The laying of asphalt pavements on Agnes street, $13,782, and bitulithic pavements on Turner, Conrad, Frank, Ashworth, Melita and Willow streets, $37,833, and concrete sidewalks on 17 streets at an estimated cost of $17,135.

Toronto, Ont., Port Credit

The water system by-law will be discussed at the next meeting of the village council. The estimated cost is between $60,000 and $100,000.

Trenton, N.S.

The installation of a water supply system, at a cost of $50,000, is proposed by the town council.

Victoria, B.C.

Tenders will be received by City Purchasing Agent, W. Galt, until 4 p.m. May 4th, for 10,000 ft. 4-in. steel pipe for waterworks purposes.

Winnipeg, Man., St. Vital

Tenders addressed to the Reeve. Grand Vital P.O., will be received until 2 p.m. Aprill 22, for the supply and construction of 1,883 ft. of 24 in.; 2,951 ft. of 20 in.; 8,373 ft. of 18 in.; 8,733 ft. of 15 in.; and 8,990 ft. of 12 in. vitrified sewers. Plans and specifications at the office of the Municipal Engineer, Municipal Hall St. Marys Rd., St. Vital.

Wallaceburg, Ont.

Tenders for the waterworks system close with the Clerk, H. E. Johnson, May 5th. Contract "A1," laying water mains; contract "A2," laying sewers; contract "C," water tower and foundations; contract "D," water pipes and specials; contract "E," fire hydrants, gate valves, valve boxes; contract "F," mechanical pressure filters; contract "I," intake and basin; contract "M," laying force main; contract "S," furnishing sewer pipe. Plans and specifications are at the office of the Engineers, Chipman & Power, Mail Bldg., Toronto, and at the Resident Engineer's office, Wallaceburg.

Yarmouth, N.S.

The laying of clay pipe sewers, at an estimated cost of $50,000, is being considered by the town council.

CONTRACTS AWARDED

Elmira, Ont.

A contract has been awarded by the town council to A. M. Bauman for digging, backfilling, tapping mains, furnish-

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 659 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 April 22, 1914 **No. 16**

Principal Contents

Workmen's Compensation in Ontario 475
Canadian Municipalities Need Controlling Influence .. 475
Engineering Prospects and Opportunities 476
By F. H. Fay.
Design and Operation of Tremies for Depositing Subaqueous Concrete 477
By J. R. Middleton
Constructional Features of the Georgia-Harris Viaduct at Vancouver, B.C. 478
Explosions in Sewers—An Investigation of Causes and Preventive Measures 480-1
By H. J. Kellogg
Permanent Bridges and Their Advantages 482-93
By Daniel B. Luten
The Special Application of the Various Roofing Materials 494-5
Desirability of Co-operation Between Architects and Contractors 496
By Charles A. Bowen
Technical and Economical Aspects of Road-Building in Quebec 497-500
By Gabriel Henry
Letters to the Editor 501
Building Activity in Montreal and District 502
Constructional, Personal, etc. 502-6

Workmen's Compensation in Ontario

EMPLOYERS of labor in general, and contractors in particular, throughout Ontario may well view with apprehension the Compensation Act which the province is about to put through, and **should oppose it tooth and nail.** Objections to the bill may be said to be legion, but one of the most serious is that under certain circumstances the employee is enabled, without regard to negligence on his part, to obtain compensation to the extent of 55 per cent. of his former earnings, the payments to be continued, if necessary, for life and in the event of death to continue to the widow or other dependents.

Of all spheres of activity, contracting and allied work are perhaps the most susceptible to accidents, and in spite of the "Safety First" movement and the extra precautions for which it has been responsible of late, the dangers attendant upon the execution of large building and engineering works have not been lessened—due perhaps to the increased magnitude of such enterprises and the growing demand for speed in construction. This the employers realize and after making every possible provision to prevent mishap to life and limb they are united in the opinion that the workman injured in their service while engaged in the proper performance of his duties should receive adequate compensation under a well-balanced business form of administration. The opposition is to a bill which teems with anomalies and inconsistencies and suggests the possibility of much tiresome litigation—arising out of the overlapping of the trades as classified under the act.

It is understood that the government recognizes that the proposed measure has its shortcomings and that amendments will be made later, but this does not alter the fact that the bill is likely to become law under the present status of affairs, neither does it compensate the employers for the injustice of having the act administered by a government-appointed commission who will have such power as to enable them to interpret their own powers and sit in judgment upon their own decisions.

As it stands, the act is one of the crudest attempts to legislate the vexed question of compensation ever made.

Canadian Municipalities Need Controlling Influence

NOT long since, the London correspondent of this journal discussed the advisability of having some central authority, such as the Local Government Board in England, to control municipal borrowing in Canada, it having been argued that some such authority would tend to place Canadian municipal credit upon a better basis in financial centres. With this idea we are thoroughly in accord, for undoubtedly Canada is suffering at the moment from the effects of bad management in her towns and cities.

During the last few years the country has been passing through a period of reckless irresponsibility in financial affairs, and the relation between capital and current expenditure has been almost entirely overlooked. Perhaps the worst feature of it is that in many cases while money was being squandered in one direction legitimate enterprise was being stinted in another—as a single example of which may be cited the miserably inadequate appropriation made in the first instance for the Toronto filtration plant, which was found to be hopelessly too small before it was half finished.

The crying need of a Municipal Department is becoming more apparent and its feasibility has been the topic of considerable discussion. Particularly is this the case in Ontario, where it is thought that a department of the provincial government might accomplish much in the way of acting as a restraining and guiding influence upon the lesser municipalities in particular. It is contended, with much reason we believe, that a capable Minister at the head of such a government department would soon become a leader of public opinion in municipal affairs, Public opinion on matters municipal is moribund—a condition which is not difficult to understand when one considers by what incompetent men the taxpaying resources of many of our towns and cities have been exploited of late.

One of the objections is that it would be almost impossible to find men of sufficiently broad experience to administer the affairs of such a department. This is mere quibbling, for in both Toronto and Montreal there are at least a dozen men competent to render excellent service—municipal engineers who have graduated into consulting practice and retained the essence of many years' broad experience in financing and carrying out municipal work. Such men are to be obtained, but of course they have their price. A salary of $10,000 a year would perhaps attract the right kind of men and if such a figure were paid and a department were organized for every province, with perhaps a supreme authority under federal control, money would be saved to the country many times over.

The very life of our progress depends upon our maintaining high municipal credit. Is this being done under the present system of municipal administration?

Engineering Prospects and Opportunities[*]

By F. H. Fay[†]

THE future of engineering is bright. Opportunities are expanding. The world is coming to expect and to demand a higher standard of the engineer and of engineering. Engineering is the oldest of all professions, and dates from the earliest and most elementary civilization; but it is only within comparatively recent years that it has become recognized as a distinct profession, and we must still look to the future for that full recognition to which we engineers believe the profession is entitled.

In every field of activity the world is coming more and more to depend and rely upon engineers. But to meet these demands, engineers themselves must grow and become broader men. The successful engineer of today and of tomorrow cannot be like the engineer of yesterday, who too often would "retire into the technical recesses of his professional work and content himself with being the servant of other men." The engineer of to-day should be a broad-gauge man, aggressive, alert, in touch with public questions outside his own narrow field, and a leader—not a follower—of men. It is upon the development of the qualities in engineers themselves that the whole future success of the profession depends.

The best technical school training for an engineer is one which gives a thorough grounding in the fundamental subjects of science and engineering without frills and specialties. In response to popular demand, there has been in most of our technical schools during the past few years, a tendency to too high a degree of specialization. Fortunately, a reaction is setting in, and in the best technical schools to-day, courses are being rearranged so as to give the student a more thorough training in science and the general principles of engineering, with less specialization.

There is one quality of highest importance to the success of the young engineer, which cannot be taught in schools and which he must gain for himself, and that is the ability to properly meet and mingle with his fellow-men. In other words, he should be what is popularly known as a "mixer," and failure in this direction is responsible for the lack of, or limited, success, of many an engineer who has the other requisites, and who but for this lack would undoubtedly achieve a far higher position.

The engineer should be a manager, and should give orders to others who can do the work under his direction as well as he himself could do it with the situation reversed. It should not be considered unprofessional for an engineer to be a capitalist, and, when he takes his proper place as promoter and organizer and shares in the profits of engineering enterprises, he will no longer be taunted with the saying that "an engineer is only good to spend other people's money." It is by acquiring individual strength that the engineer can give strength to the profession. It is well known that engineers of admitted proficiency often have to work under the direction of men who are unfitted by education and experience to direct engineering work. This is because the engineer is a workman while the other party belongs to the class of "managers." The engineer has not reached his proper rank until he can hold the position of manager, as well as that of a designer and supervisor of work.

Engineers themselves are frequently responsible for the low estimate which the public places upon the value of engineering services. Chief engineers of corporations and public boards too often make the mistake of hiring engineering assistants at the lowest possible wage, under the false impression that by such rigid economy they are enhancing their own value in the minds of their employers.

Such practices do grave injury to the whole profession and cheapen it in the estimation of the public. Furthermore, they tend to react to the disadvantage even of the chief engineer, for his employers will reason that if the rank and file of engineers can be hired so cheaply, engineers as a whole are a cheap lot, and high salaries are not necessary in any grade, even that of the chief engineer himself. The chief engineer who pays a fair wage, taking account of the time and money which the young engineer has spent in securing his education and training (his working capital), will not only secure better, more loyal and more efficient service, but will help to raise the standard of the whole profession.

---

[*] Extract from the Presidential Address before the Boston Society of Civil Engineers at the recent Annual Meeting.

[†] Division Engineer, Public Works Department, Boston, Mass.

Preliminary plans are being drawn up by an English firm of engineers for the Lachine Rapids Power Company. It is proposed to develop hydro-electric power on the north and south sides of Heron Island, situated in the centre of the Lachine Rapids, near Montreal. Should the project be carried out it will entail the expenditure of at least $6,000,000, the idea being to supply power to Montreal industries.

Design and Operation of Tremies for Depositing Subaqueous Concrete

By J. R. Middleton, Assistant Engineer-in-Charge C. P. R. Bridge, Pitt River

THE use of the tremie as a means of placing concrete under water is discouraged by a great many engineers, who are inclined to look upon this method as a last expedient and allowable only in cases where the use of the deep sea sealing bucket is impossible. It must be admitted that this aversion is frequently quite justified, as on a great many jobs the most amateurish attempts are made at this class of work. In the hope that it may be of interest to readers who have not as yet had occasion to use tremies, the writer ventures to give a few hints, gleaned from experience, on their design and operation.

Principal of Operation

A tremie consists essentially of a pipe, of the necessary length to reach bottom, provided with a hopper at the upper end for receiving the batches. The whole is suspended vertically in such a way that it reaches bottom, and may be raised as the work progresses. Assuming for the moment that the preliminaries, which will be looked into later, have been attended to, and that the work is well under way, then the following conditions should obtain: (1) The pipe should be absolutely free from water at all times; (2) as each fresh batch is deposited in the hopper it should slide easily down the pipe for a few feet by its own weight, or by a slight raising of the tremie. The first condition requires that the pipe be water-tight throughout the whole of its submerged length, and that its lower end project into the deposited mass a distance sufficient to prevent any influx of water. The second implies that the concrete is mixed "wet" enough to flow easily. This "soupy" condition not only facilitates its passage through the pipe, but assures also that a fairly level surface will be obtained at the bottom without an undue number of shifts in the tremie position. From the above it will be seen that, under ideal conditions, each single batch is deposited below the surface of the mass, and never, while retaining its identity as a batch, comes in contact with the water. The mass surface, the only concrete exposed to the water, should never be disturbed sufficiently to cause any serious wash.

Design

The most satisfactory tremies have been constructed as follows: The hopper was built of sheet iron, 4 x 4 feet, with vertical sides for a depth of 9 inches. In a further depth of 1 foot 3 inches the sides are battered in to leave a hole 12 x 12 inches. They are then drawn in to form a pipe just large enough to be inserted into a short length of 10 inch W. I. pipe fitted with a flange joint on the lower end. The hopper is joined to the short pipe by four vertical riveted bands, and the joint, which should always be kept above water is caulked so as to be "grout-tight." The remainder of the tremie is made up of lengths of 10 inch W. I. pipe, with screw joints, except the top one, which is flanged to connect with the short piece riveted to the hopper. All screw joints should be greased and the flange joint gasketed to insure water-tightness. A heavy band is riveted round the top edge of the hopper for reinforcement, and to carry a cable sling for hoisting purposes. Sealing has been carried out at a depth of almost 100 feet with tremies of this description, the only difference being that spiral riveted pipe with flanged and gasketed joints was substituted for the W. I., in order to save weight.

Handling and Inspection

The most satisfactory method of handling the tremie, and the only method in deep work, is by derrick. In shallow water, however, where only one derrick is available both for supplying the concrete and moving the tremie, a crib support may be built on the cofferdam struts, and the derrick hooked on only when it is necessary to raise it a little. A separate derrick is much preferable, owing to the fact that the spring in the boom helps to jar each batch through the pipe, and also because of greater speed. On starting work, the tremie is lowered till it rests on bottom, and is then raised three or four inches in order to give the first batch room to expel the water. A couple of cement sacks placed in the pipe act as a plug and prevent any tendency of the water to work through the first batch. The first, or at least the second batch, should drive all the water out through the pipe bottom and seal it. A light lowered at intervals into the pipe will soon show up any slight leak.

When working properly, the pipe will give a peculiar "roaring" sound as each batch drops down. Should the bottom not be sealing well, a column of water will shoot up the pipe after each batch. In cases where there is a leak in the pipe above the seal, it will be found that shortly after each batch is deposited there will be a "boiling up" of water through the batch which will wash most of the cement and a good deal of the sand to the surface, forming a rich grout at the top and leaving washed gravel below. This is caused by the accumulated water from the leak lying on the surface of the concrete in the pipe and being forced up through each new batch as it is dropped into place. It probably is more harmful to the concrete than even faulty sealing of the tremie bottom. When concreting in piled foundations, it will sometimes be found that, although the pipe is apparently quite watertight and the lower end close enough to the bottom to seal properly, there is still trouble from wash and excessive clogging. This usually indicates that the free exit at the pipe bottom is partially closed by an obstruction, such as a "nest" of piles, and ashift in the tremie position will usually get over the trouble. Should the bottom, as is frequently the case, be composed of river silt or clay which has been converted into a semi-liquid mud by the action of the water jet when driving piles, it will be found that the concrete will sink below the surface of the mud and spread itself imperfectly over the bottom, forming a very poor seal, and being full of mud "pockets." In cases of this kind, the most satisfactory method is to first lay a thin sealing course with the idea of confining the mud. After setting, the whole seal is cleaned over with a hydraulic sand elevator, and most of the surface mud removed, after which the main seal may be deposited with practically no further trouble from mud.

Constructional Features of the Georgia-Harris Viaduct at Vancouver, B. C.

CONSIDERABLE progress has been made during the spring and winter months with the construction of the Georgia-Harris viaduct now being erected for the city of Vancouver by Messrs. J. McDiarmid & Company, of Winnipeg and Vancouver. This structure stretches from the west end of Harris Street in a westerly direction to the eastern end of Georgia Street, crossing over an arm of False Creek, the properties of the Canadian Pacific Railway, British Columbia Electric Railway and the Great Northern Railway. The viaduct was designed by Mr. C. A. P. Turner, the inventor and patentee of the "Mushroom" system of reinforced concrete construction, and is intended to relieve the problem of handling heavy traffic between the west and east districts of the city.

View of Warren trusses, looking east.

The total length is 2,854 feet and the outside width is 66 feet, comprising a central roadway 53 feet wide carrying a double track for street cars, and two 6 ft. 6 in. sidewalks. For about 900 feet from the Georgia Street end the structure consists of four parallel Warren continuous trusses, the erection of which is almost completed, over 900 tons of steel having been put in place in a little over 8 weeks. From the end of the steel trusses for a distance of 280 feet there will be seven standard Mushroom spans varying in width from 37 ft. 9 in. to 43 ft. 6 in. the latter being the largest Mushroom span on the structure. The succeeding stretch of 150 feet consists of 3 parallel reinforced concrete girders with two spans of about 60 ft. which are cantilevered out from each end support. Only the footings on this portion have as yet been completed. Owing to the nature of the ground here, most of which is fill, it was found necessary to carry the footings on piles of which 10 to 13 were required for each footing. In passing over the site of the old Royal City Mills (now owned by the B. C. Electrical Railway Company), it became necessary to use steel points on a large number of the piles as in some places there was over 14 ft. of fill consisting of old slabs, logs and mill waste.

The viaduct is carried over the Great Northern Railway tracks on continuous girders of reinforced concrete with spans varying from 50 to 83 feet, the length of the spans having been determined by the position of the tracks. Next comes the arch over False Creek with a span of 123 feet cantilevered out from each support. This is followed by 12 spans of the Mushroom type ranging from 25 ft. to 30 ft. after which 69 ft. of fill connects with the Harris Street end. The first twelve spans projecting from Harris Street were completed some time ago. Concrete is being placed by Ainsley's patent spouting system, in connection with which there are two 190-foot towers in use at each end of the viaduct. About 600 feet of the structure can be concreted before it is necessary to move the towers to a new position.

The concrete caissons, 12 feet in diameter and 40 feet high of which there are six altogether have been sunk in place and filled with concrete. These caissons support the foundations in False Creek. Almost all of the reinforcing steel required for the entire structure has been bent ready for placing. Owing to the length of this steel—some of it being over 110 feet long—it was found difficult to get delivery from the mills and resort was made to splicing by means of turn-buckles. A number of the rods have as many as 17 bends and weigh nearly 500 lbs. Despite their unwieldy size, the rods were handled and bent with economy and ease by four competent workmen.

Rapid progress has been made in fashioning the high class ornamental cast stone hand railings and lamp standards of modified Corinthian columns which will add the finishing touches to the viaduct. Nearly all of the stone has been cast and a large proportion is completed and ready for erection, while a small stretch is already in position. The stone is being cast directly on the job and to judge from it's attractive appearance should provide a fitting form of decoration to a splendid example of modern viaduct construction.

The false work for the arch span over False Creek

Warren trusses, showing temporary wooden bents carrying structure before rivetting.

is being carried on 42 piles placed in six rows, three on each side, a 35-foot channel being left to allow the owners of the adjoining waterfront the use of the waterway during the progress of construction.

The form work for that portion of the structure carried by the Warren trusses is an interesting piece of work, the deck being carried on 8 x 16-inch timbers on 12-foot centers, the 8 x 16-inch timbers resting on the lower chords of the Warren trusses, every alternate one being cantilevered out from the trusses to carry sidewalks forms. Expansion rollers are used at the base of the legs which support the Warren trusses the expansion in the trusses being taken care of by four such sets of rollers while provision for the expansion of the concrete portion of the viaduct is made where necessary.

The telephone wires and gas mains across the viaduct will be hung from the under side of the deck while the conduits for the B. C. Electric Railway Company's wires are embedded in the concrete sidewalks. A few statistics of the amount of material required on this work may prove interesting. For reinforcing purposes, 1,200,000 lbs. of steel will enter into the bridge as well as 1,200 tons of structural steel. For the concrete portions upwards of 20,000 cubic yards of concrete are required, and for the foundations, etc., nearly 30,000 piles will be driven before the completion of the work. In the composition of the concrete for the viaduct there enters 24,000 barrels of cement and 26,000 cubic yards of sand and gravel. The structure at its highest point will be 40 feet above the railway tracks underneath, and this height is maintained almost throughout the entire length of the viaduct, namely, 2,854 feet. The work is being carried out under the direct supervision of Mr. A. P. Hueckel, district engineer for Mr. C. A. P. Turner, the consulting engineer and Mr. F. L. Fellowes, supervising city engineer of Vancouver. Mr. T. Borgferd local manager for Messrs. J. McDiarmid & Company, has charge of the actual construction. The total outlay involved will be approximately $500,000.

Portion of roller nest which allows for the expansion of the steel trusses.

"The Influence of Ice on Waterpower Developments" was the subject of an interesting lecture given before the Montreal Engineers' club recently by Professor H. T. Barnes of McGill University. The problem with which Dr. Barnes is at present engaged and which he explained by photographic illustrations, is to keep the great northern waterways open in the winter months. His experiments included the idea of diagonal booms above the dam, and the forcing of hot air or steam on the surface of the water at the head of the dam.

Making Blueprints from Blueprints

The making of a blueprint from a blueprint is described by a correspondent as follows: To obtain good results, a clear, sharp and rather dark print is essential, for if it is blurred or light, it will not reproduce satisfactorily.

The method consists of coating the print with a little kerosene and then printing immediately. The oil used will not affect the reproduction of the new print, unless it is applied very thickly, nor will it spoil the original, as the oil soon dries, leaving the print in as good condition as before. This process will also work perfectly when it is desired to make prints from heavy drawings. It has been used with success to make blueprints from printed matter. To make the original perfectly transparent, apply a coat of boiling hot paraffin.

The Failure of Dams

A paper on "The failure of dams" was read last month before the Liverpool Engineering Society by Mr. J. R. Davidson. The author said that unsound foundations had been the most fertile source of disaster to masonry and concrete dams, while in the case of earthen embankments either inadequate provision for dealing with floods or faulty arrangements for drawing off water had been chiefly responsible for failure. Two of the three masonry or concrete dams which he referred to had failed in quite different ways through faulty foundations. The third was a case of pure overturning, which is unusual but none the less instructive. The remaining examples were two earth banks, which illustrated each of the above-mentioned causes of failure. After referring to the troubles which brought about the failures, Mr. Davidson said that the lessons to be learnt might be broadly summarized as follows:—A gravity dam of masonry should be wholly founded on rock; tensions should be practically non-existent in a masonry dam; in an earth dam settlement should be provided for, and unequal settlement prevented; adequate provision should be made for exceptional floods under all conditions; and a secure foundation and prevention of uplifting were necessary in masonry and concrete dams.

North Toronto's Extension Sewerage Scheme

An extensive sewerage scheme for North Toronto district has been submitted to the Works Committee by Commissioner Harris in a detailed report, in which he estimates that the whole cost of the work, including two sewage disposal plants, a complete system of trunk, lateral and storm outlet sewers, and additional trunk sewer accommodations, will amount to $4,144,256. The additional trunk sewer accommodation is required to drain the neighboring watersheds at present outside the city limits. Of the expenditure the city at large will be asked to contribute $2,781,945, and the ratepayers benefited will be assessed for $1,362,311. The scheme is divided into two districts, north and south, with Eglinton Avenue roughly as the line of demarcation. A feature of the Commissioner's recommendation is that legislation will be asked for power to assess outside areas, upon annexation, which share in this provision for drainage. Two storm outlet sewers are to be constructed, one through the Waterworks Park, and the other from Bayview Avenue to the Don River, through private property. A sewage disposal plant will also be built.

Explosions in Sewers—An Investigation of Causes and Preventive Measures

By H. J. Kellogg, City Engineer of New Haven, Conn.

THE Department of Public Works of New Haven, Conn., has been for the past year and is still investigating the causes of explosions in sewers and underground conduits, and endeavoring to find means of preventing such explosions. In New Haven, about twenty years ago, while four men were cleaning a 54-inch circular brick sewer, an explosion knocked the men down and momentarily stunned them, broke a pick handle and bent the framework of the iron truck which was used to carry the sewage deposits, and apparently exhausted the oxygen in the air so that the men were nearly suffocated before they could reach the manhole opening. Incidentally, it blew the water out of the sewer, a great deal of it being forced back through the house connections into the plumbing appliances. Two of the men were disabled for six months or more. One of them, Daniel Lawler, who is now superintendent of sewers, said that there appeared to be a great ball of fire coming like a bolt of lightning from the upper end of the sewer. There was a gas plant nearby, and in those days the manufacture of by-products from gas wastes was very limited, also gas drips were run directly into the sewer where it was convenient; and it is believed that illuminating gas had been ignited by the lanterns carried by the men.

About a year ago, in another New Haven sewer, 42-inch egg-shaped brick, there was an explosion while men were inside cleaning it, and they were burned about the faces and hands but were not otherwise injured. In this case illuminating gas did not appear to be the cause, but it was believed to be due to waste benzine or naphtha mixture used by the National Paper Box & Paper Company for cleaning lithographic stones. The evidences against this was by no means strong, but a gasoline odor was noticed by the men before they entered the sewer, and no garages were known of located above that point. The manholes had been left open for a length of time that was thought sufficient to clear the sewer atmosphere, and ordinary lanterns were carried. This second explosion led to the adoption by the sewer department of a small, neatly-made dry battery lantern carrying a small mazda lamp. Smoking and lighting of matches in the sewer is forbidden, and it is believed that this will prevent explosions while men are working in the sewers.

These are the only instances in New Haven where lives have been endangered from sewer explosions, although several small explosions have been caused by unknown agencies. The earliest of these latter explosions occurred in 1886, when the arch was blown completely off of a 60-inch circular brick sewer for about fifty feet each side of a railroad track which it passed under. No information was ever obtained as to the cause. This is the only instance in that city of damage to a sewer by an explosion.

A number of explosions have occurred in underground wire conduits, some of them serious and expensive. In Bridgeport, about two years ago, a manhole cover was blown off by ignited illuminating gas, and the gas continued to burn for hours before it could be stopped, the sheaths around the cables and the insulations being destroyed. In the same city, two years earlier, an explosion in a conduit manhole broke forty panes of glass in adjacent buildings. A riser pipe had been cut off just above the curb, and a ventilator cap on this permitted the escape from the manhole of any illuminating gas. A boy striking a match on this ventilator cap started the trouble. In the same city a spark given off by a trolley car on a gritty rail touched off a blast that blew up 675 feet of ducts. The telephone company of Hartford, Conn., received $5,000 damages from the gas company of that city for an explosion caused by illuminating gas. Ventilated manhole covers have checked this line of conduit troubles, but a bad break in a gas main would threaten the underground system, as trolley car wheels or hose shoes sprinkle sparks. In Columbus, Ohio, according to C. J. Lauer, chief of the Fire Department, there have been two explosions in underground conduits for telegraph and telephone wires, caused by accumulations of natural gas which were touched off by the fire engines passing over the manholes and igniting the accumulated gas. In one of these instances a heavy telephone manhole cover was blown off and some damage done to the wiring inside.

Pittsburgh Holds the Record

Pittsburgh holds the world's record for the wreck of a sewer from an explosion, and no community cares to wrest that distinction from it. It is hard to believe that over a mile of an 8-foot sewer could have been completely shattered from one convulsion; but so it was, and it may cost half a million dollars to repair the damage. The engineers of the Department of Public Works have been able to assign no cause for the explosion.

In Charleston an employee lighted a cigarette and threw a match into a manhole just uncovered. At another time two men were caught by a flash in a sewer which singed their hair. In Philadelphia an explosion attributed to gasoline vapor injured several men recently. On another occasion a suspicious smell was noticed upon opening a sewer manhole, and a blazing paper was thrown in, resulting in a column of flame about 40 feet high, due to gasoline from a nearby factory. About two years ago two men were killed in the city owing to a leaky gas main which ran parallel with the sewer, and about a year and a half ago a man was burned from gasoline from a dry cleaning shop. In Detroit, on January 28, 1914, an explosion occurred due to gasoline which caused damages running into the thousands, and the force of which extended for a distance of 19,000 feet.

George H. Norton, deputy engineer commissioner of Buffalo, N.Y., wrote: "For three years past, at periods of thawing weather following frost and heavy snow, we have had serious complaint from gas odor in some of our sewers. This has been traced down and found to be due to the use of the railroads of what is called hydrocarbon oil, which is used by them to prevent freezing of their switches and interlocking plates in the passenger station yards and at other congested points. An examination was made by our city chemist, and he reports that at low temperatures this oil will crystallize, that such crystals are soluble in water, and for this reason he thinks that the gases have passed the ordinary vent sewer trap. The gases arising from this oil are apparently highly explosive, and could readily be the cause of a serious explosion. This oil is a by-product from the Pintsch gas used for car lighting. After a lengthy consultation with the railroad authorities, they have agreed to discontinue the use of this oil in their yards."

Hartford had two serious explosions in sewers in 1913, one lifting a manhole head and throwing several covers into the air and shattering windows in adjoining houses. This and the second also took place near the works of the Gas Light Company, and suits against the company were brought by property owners.

The inspector of combustibles of New York City reported that since June 5, 1912, there have been eleven sewer explosions, but as conditions in the sewers are so complex and opportunities for observation so limited no definite knowledge could be obtained of the causes of the explosions. As far as they can judge, however, the probable causes are gasoline, illuminating gas and calcium carbide. "Prior to the regulation requiring the installation of oil separators in garages, the larger number of sewer explosions was limited to what is known as the garage zone, lying west of Broadway to the Hudson river between 40th and 60th streets. Since their installation, the number of explosions has been greatly reduced. Illuminating gas enters the sewers from ruptured, corroded or broken gas mains or from leaky joints, and when mixed in the proper proportions with air forms an explosive mixture. Calcium carbide, which is used in garages for generating light, may be thrown into the sewer, and when in contact with water generates acetylene gas, which is an intense explosive and is also auto-combustible, so that in many instances it may be lighted by its own heat generated in evolving the acetylene. The vapors of gasoline and illuminating gas require an open flame to ignite them, but how this occurs in sewers it is impossible to tell; but in vaults and in conduits the igniting spark is furnished in a number of cases by electrical apparatus, such as switchboards, sump pumps, short-circuiting, etc. . . . In relation to places where oil is stored, the oil separator is the only method at present under the regulation for preventing volatile inflammable oil from discharging into the sewer."

It is difficult to compel garages to install oil separators, however. A letter from the Ansonia Manufacturing Company, of New York, which makes oil separators, says: "The garage owners at one time combined and fought the ordinance in the courts, and after several appeals finally lost their case, with the result that this matter will be pushed harder than ever. Their contention was that it was an injustice to impose such expense on the small garage owners and individuals, because they felt it was entirely out of their means to comply with this ruling. . . . . . Some of the boroughs make a distinction between private and public garages by calling any garage which stores more than two cars a public garage, and make only public garages subject to the ordinance."

Illuminating gases can be kept out of the sewers more easily than out of wire conduits, as the latter lie nearer the surface and afford better channels for the escape of the gas that may accumulate under the nearly gas-tight pavements. In New Britain it is intended to have ducts calked with oakum and some impervious substance like tallow that can easily be taken out and replaced. Also greater care is generally taken now in laying gas mains and calking joints. New Haven is considering requiring every garage to have an inexpensive sump or catch basin for receiving waste oils, and that the Department of Public Works be notified whenever these need cleaning and will then clean the basins and dispose of the dangerous matter in a way to prevent explosions and fires. This probably will be adopted for dry cleaning shops only. Garage sumps would not be likely to retain the oil, which would probably be evaporated, while oil separators have a receptacle to catch and hold all oils.

One volume of gasoline is said by Professor Dean to produce 141 volumes of vapor, and one part of this vapor to 62½ parts of air to furnish the best mixture for complete combustion. On this basis, one gallon of gasoline would furnish a mixture of maximum explosiveness for about 150 feet of 42-inch sewer, although, of course, consideration should be had of the time required to vaporize the oil, the motion of the air in the sewer and other factors which would complicate the problem. Gasoline vapor is heavier than air, while illuminating gases are lighter; therefore ventilated manhole covers furnish outlets for the latter, but gasoline vapors will not escape in this way. But good ventilation of the sewers would appear to minimize the danger, especially from illuminating gas. (In New Haven there appears to be no method of ventilating the sewers, either through manhole heads or house connections).

Protective Ordinances

On the subject of ordinances designed to protect sewers from combustibles, Mr. Kellogg quotes the Washington ordinance as being perhaps as good as any, this being as follows: "No person shall make or maintain any connection with any public sewer or appurtenance thereof whereby there may be conveyed into the same any hot, suffocating, corrosive, inflammable or explosive liquid, gas, vapor, substance or material of any kind; and no person shall cause to enter or flow into any public sewer or appurtenance thereof any hot, corrosive, suffocating, inflammable or explosive liquid, gas, vapor, substance or material of any kind; provided, that the provisions of this paragraph shall not apply to water from ordinary hot water boilers of residences." There are also rules for the installation of garage traps. The virtue of such an ordinance, however, lies in the enforcement of it, and all cities, both large and small, find this to be very difficult, and probably all are aware that there are numerous violations without being able to detect them.

All sand intended for use in concrete should be thoroughly washed if it shows signs of vegetable matter, mud, or other impurities. The following is a simple method of cleaning: Build a platform about 12 ft. long by 4 ft. wide, with one end about a foot higher than the other. On the lower end and sides nail 2 by 6-in. boards to hold the sand. Spread the sand over the platform in a layer 3 or 4 in. thick, and wash it with a hose. The washing should be started at the upper end, letting the water run through the sand and out over the board at the bottom. All of the sand should be thoroughly agitated during the washing, so as to allow the water to carry off the dirt. After washing, the sand should be piled up where it will not come in contact with the dirty water. Drain this water off to some suitable outlet and do not use it for mixing the concrete.

Twelve spans of 75 ft. to 90 ft. each across the Maumee River, near Toledo, Ohio.

Permanent Bridges and Their Advantages

By Daniel B. Luten, Consulting Engineer, Indianapolis, Ind.

THE day of permanent bridges has arrived. Temporary bridges have their use where funds are limited, or where it may be necessary subsequently to change the location of the bridge, but it can easily be shown that a permanent bridge, even though considerably higher in first cost than a temporary bridge, will be more economical in the end.

Let us assume, for example, that it be desired to build a 50-ft. bridge and that $1,000 be borrowed at the bank for that purpose on a renewable note bearing interest at six per cent. We will assume the life of the bridge to be that of the average steel hihgway bridge—about twenty-five years. The bridge will require re-flooring at intervals of five years at a cost of $100 each time and will require re-painting at intervals of eight years at a cost of fifty dollars each time.

For the first twenty-five years then, the cost per annum may be found as follows:

Interest on $1,000 at 6 per cent., $60 per annum.	$1,500
Reflooring four times at $100	400
Repainting twice at $50	100
Total	$2,000

or an average of $80 per annum.

Now at the end of twenty-five years it becomes necessary to replace this bridge with a new bridge. If the same kind of a bridge be purchased again, it will be necessary to borrow another $1,000 at the bank, and for the next twenty-five years, therefore, the annual charge for maintenance will be increased by the interest on the second note, making $140 per annum. For the third twenty-five years the annual charge would be $200 per annum, with $3,000 indebtedness at the bank. And at the end of a century, the annual charge for that bridge would be $320 per annum with an indebtedness of $5,000 at the bank.

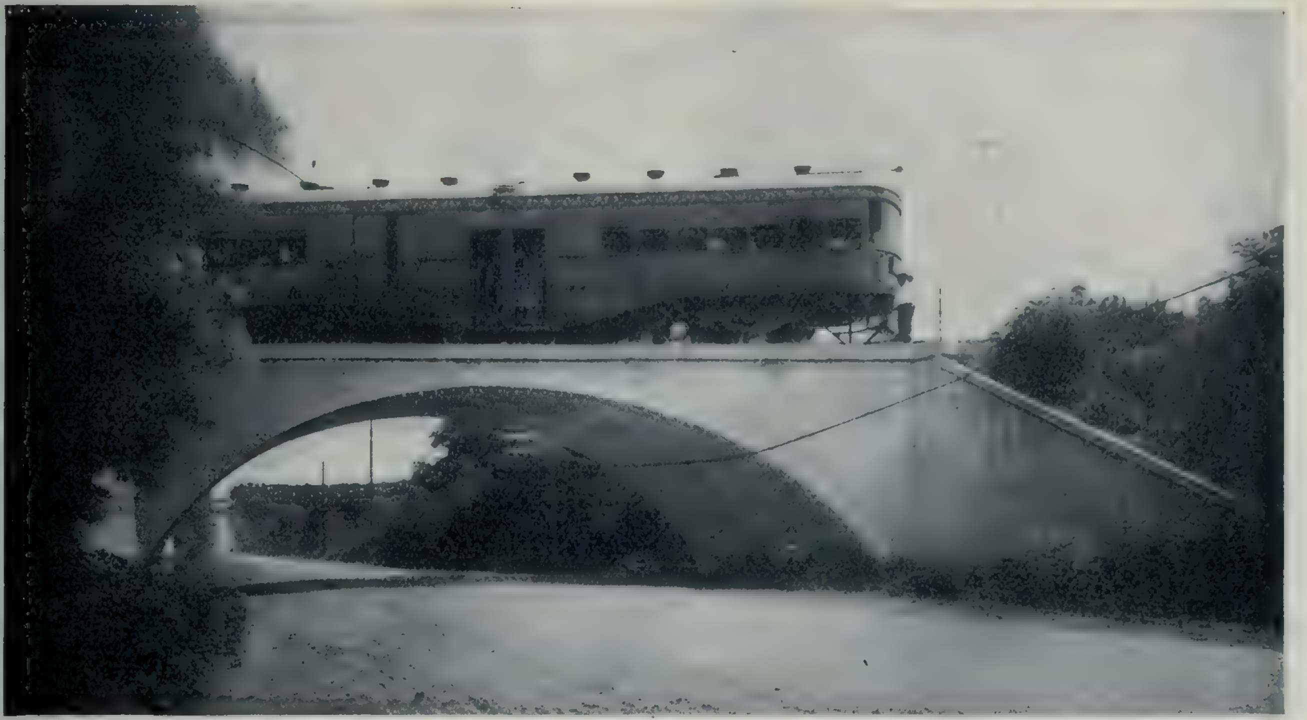
How much better it would have been in the first place to have purchased a permanent bridge even at a price that would have consumed the entire $80 charge for the first twenty-five years as interest, that is, for $1,333.33. This, then, would have been the limit of the indebtedness and the annual charge of $80 would never have been increased. On such a principle as this the State of Kansas has passed a law that a concrete bridge shall always be built where its cost does not exceed by one-third the cost of a steel bridge.

Of course, a business-like community would have a sinking fund to meet the note for the temporary bridge at the end of the first twenty-five years. But this would call for an additional outlay for each year, and if this be taken into consideration and also the fact that money can usually be borrowed by a community at five per cent. on bond issues, instead of the six per cent. we have assumed, it will be found that a permanent bridge would be economical at nearly twice the cost of a bridge that endures but twenty-five years and requires repainting and reflooring in accordance with our assumption.

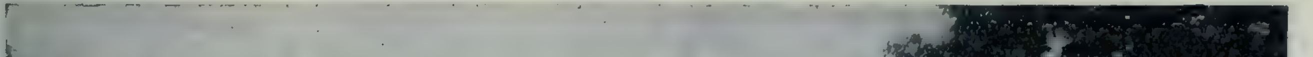
It is possible to design steel and wooden bridges so that they will be reasonably permanent. And the comparison is made here only between an absolutely permanent bridge, such as will be afterwards defined in this article, and the average steel highway bridge as built and maintained in the United States and Canada, and usually for the smaller spans. When a very large bridge is to be erected, competent engineers are usually employed—engineers whose advice may be followed with safety. But for the smaller bridges, such as are shown in the illustrations in this article, it may be desirable to have a better understanding of the requisites of an absolutely permanent bridge.

To be absolutely permanent a bridge must not only be built of permanent materials, but it must also provide for increase in weight and in volume of traffic. With modern hard roads and high speed, it should also carry the roadway itself across the stream or ravine and not have a floor that interrupts in any way the continuity of the suface of the road.

Concrete is one of the most permanent building material known to men. It is as permanent as stone and when reinforced with embedded steel has many of the advantages of steel with the permanence of stone. For the embedded steel is protected against rust by the surrounding concrete, which is a more perfect preservative for steel than any known paint. The concrete absorbs and neutralizes the carbonic acid gas, which, when combined with moisture, is the cause of rust. Moisture alone cannot cause rust, as



Concrete arch bridge on K.C., C.C., & St. J. Ry., St. Joseph, Missouri.
Span 70 ft.; skew 53 degrees.



Concrete arch bridge, Ripley, New York.
Span of waterway, 80 ft.

may be shown by placing a piece of steel or iron in water in which lime has been dissolved—the ordinary lime water purchasable at drug stores. The metal will remain for weeks without rusting, because the lime in the water neutralizes the carbonic acid gas.

Bridges built of concrete reinforced with embedded steel, therefore, have the first qualification necessary for a permanent bridge. They are rust-proof, frost-proof, fire-proof and flood-proof. The accompanying photographs show the wide distribution and acceptance by the public of such structures. Five of these photographs, all construction views, are of particular interest as showing the construction of five reinforced concrete bridges at widely separated points, under construction at the same time. These five photographs were taken in October, 1913, and represent Cicott Street Bridge, Logansport, Ind., across the Wabash River; Barrington Bridge at Barrington; Rhode Island, in the extreme eastern part of the United States; and Orland Bridge at Orland, California, in the extreme western part of the United States. These bridges each exceed $100,000 in contract price. Another construction view is the Hillsboro' River Bridge at Tampa, Florida, in the extreme southern part of the United States, built at a contract price of about $200,000, and still another view, the Saskatchewan River Bridge at Saskatoon, Sask., in the Great Northwest, built at a contract price of $400,000.

Concrete increases in strength as it grows older, the increase amounting to perhaps fifty per cent. in the year following the first month. The supports are usually removed from beneath a concrete bridge at the end of thirty days. If, then, the bridge can be properly designed to take advantage of the increase in strength of the concrete, the bridge may be expected to grow stronger as it grows older, with an increase as great as fifty per cent. the first year. An arch does take advantage of this property and the concrete arch bridge therefore provides for increase in weight of traffic by increased strength of the bridge as it increases in age. And it is the only type of bridge that has this quality. Even the girder or slab bridge of concrete cannot increase in strength with age, unless it has been designed originally with an excess of steel. And of course it is a well-known fact that steel and wooden bridges begin to grow weaker from the first day of their erection.

A bridge that increases in strength fifty per cent. in the first year and continues to increase slightly after that as does the concrete arch bridge, provides fully for almost any increase in traffic that may be expected on our highways in the future. Such a bridge is now ordinarily designed for a load of 150 lbs. per square foot or a 20-ton road roller. When this loading is used as the basis of design, the concrete arch bridge in almost all cases will compete successfully with the steel bridge designed for the same loading. And hence it will come well within the limits of economy laid down at the opening of this article.

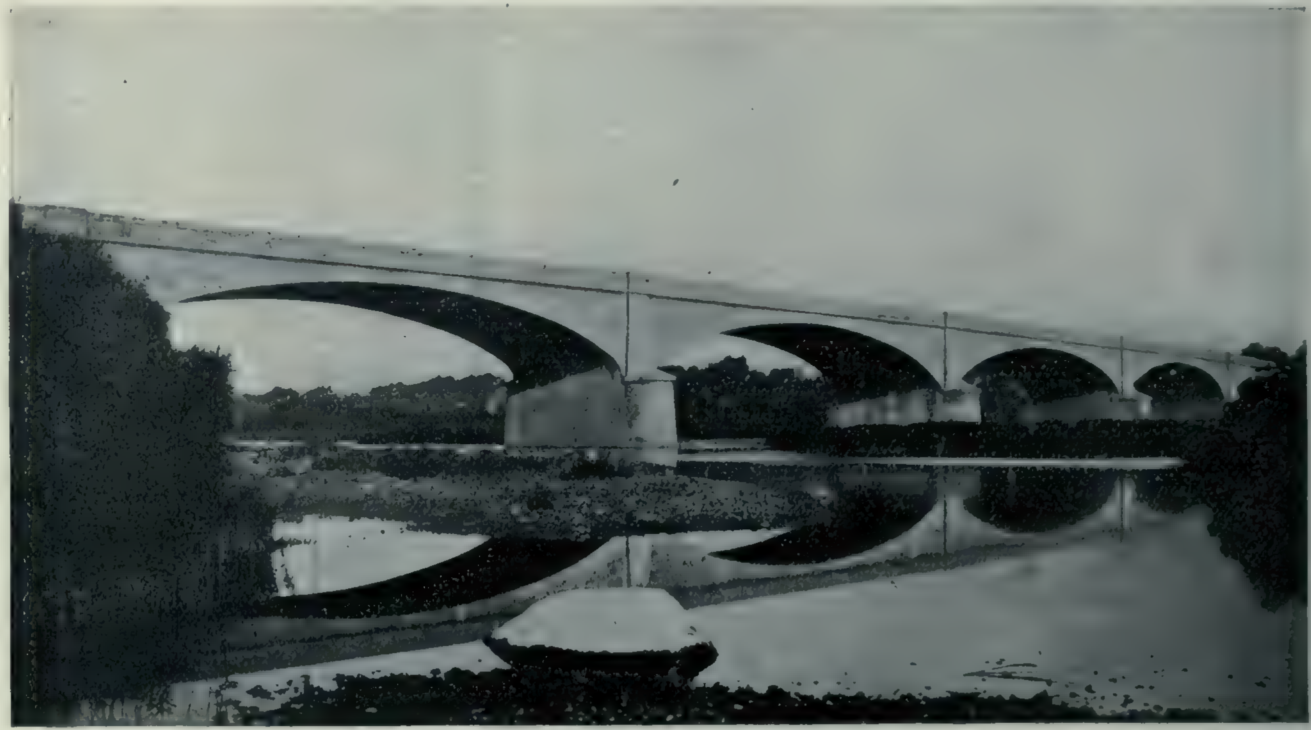
The other requirement that a bridge should provide for increase in volume of traffic necessitates that its supports be beneath the roadway surface. If, for example, the roadway be supported by trusses at each side which extend above the roadway surface, it is not possible to widen the bridge for future traffic without destroying the superstructure. A second similar bridge could of course be erected beside the first, but only as an unsightly and unsatisfactory solution. If, however, the supports for the bridge be under the roadway, as in the case of a deck girder bridge, or an arch bridge, then the bridge may be widened at any time by simply extending the substructure and adding to its superstructure without destroying the part originally erected; hence there is no loss of the original

(Text concluded on page 493.)

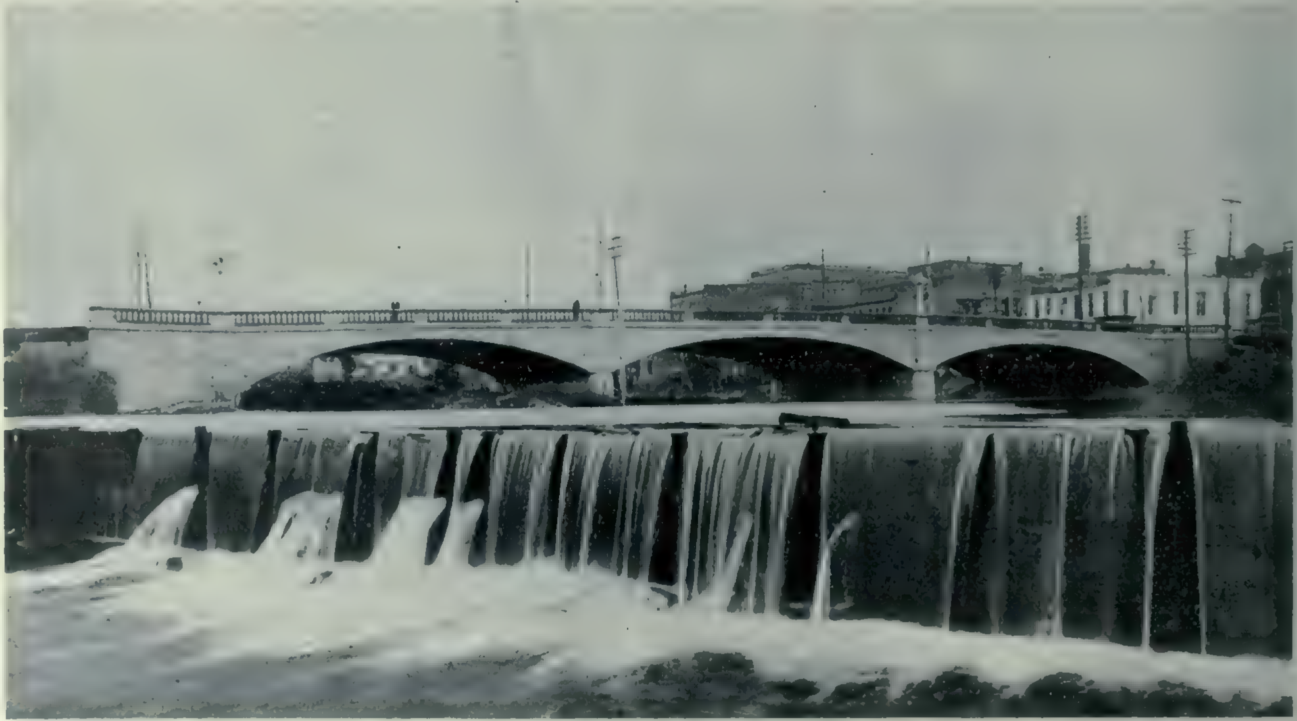
Concrete arch bridge (under construction in 1907) across the Maumee River, near Toledo, Ohio. Twelve spans of 75 ft. to 90 ft. each.

Concrete arch bridge on C. & L. M. Ry , Lima, Ohio.
Twin spans of 60 ft. each.

Concrete arch bridge on Pittsburgh Street, Newcastle, Pennsylvania.
Twin spans of 75 ft. each.



Concrete arch bridge on Wayne Street, across Wabash River, Peru, Indiana.
Seven spans of 75 to 100 ft. each.

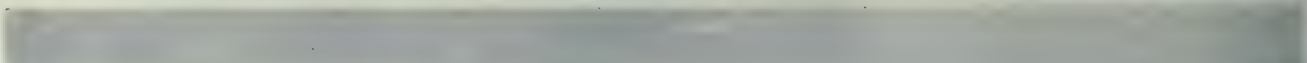


Concrete arch bridge on Eighth Avenue, across Sioux River, Sioux Falls, South Dakota.
Three spans of 72 to 80 ft. each.

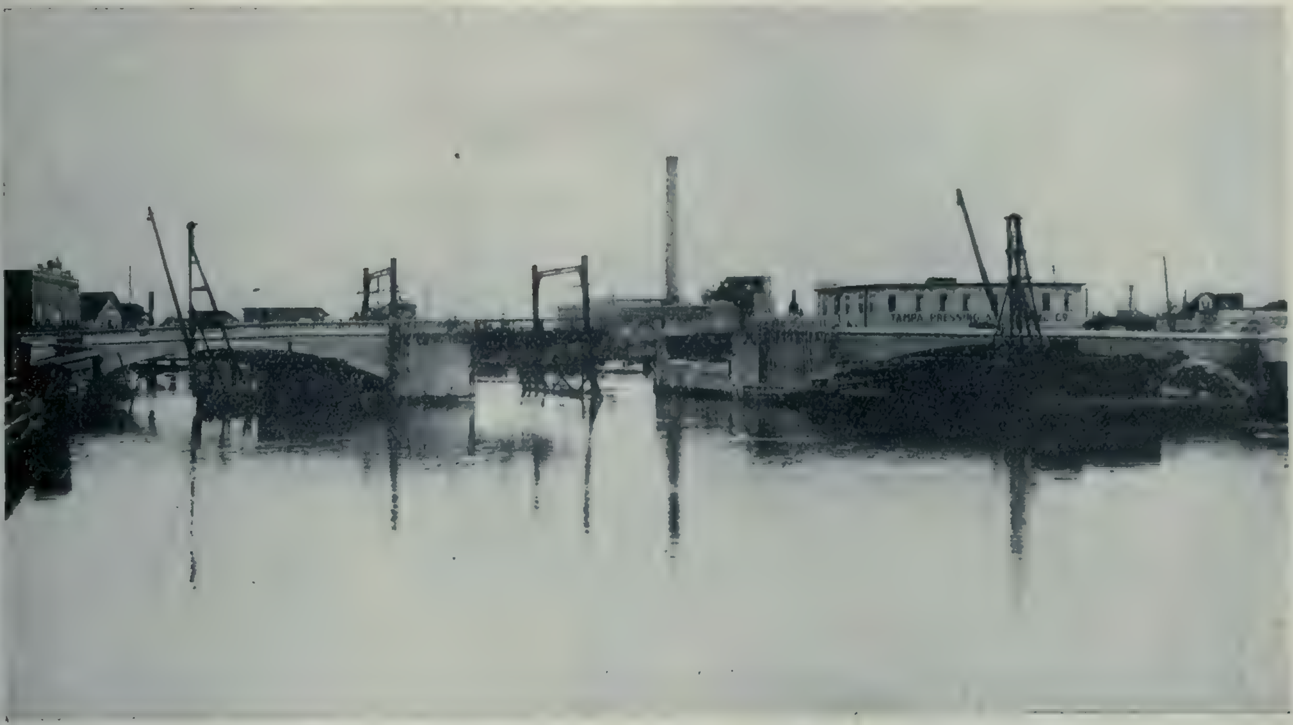
Gravelled roadway over concrete arch bridge, Plainfield, Indiana.
Three spans of 45 to 55 ft. each.

Cicott Street bridge under construction, October 1913, Logansport, Indiana.
Six spans of 96 to 108-ft. each.

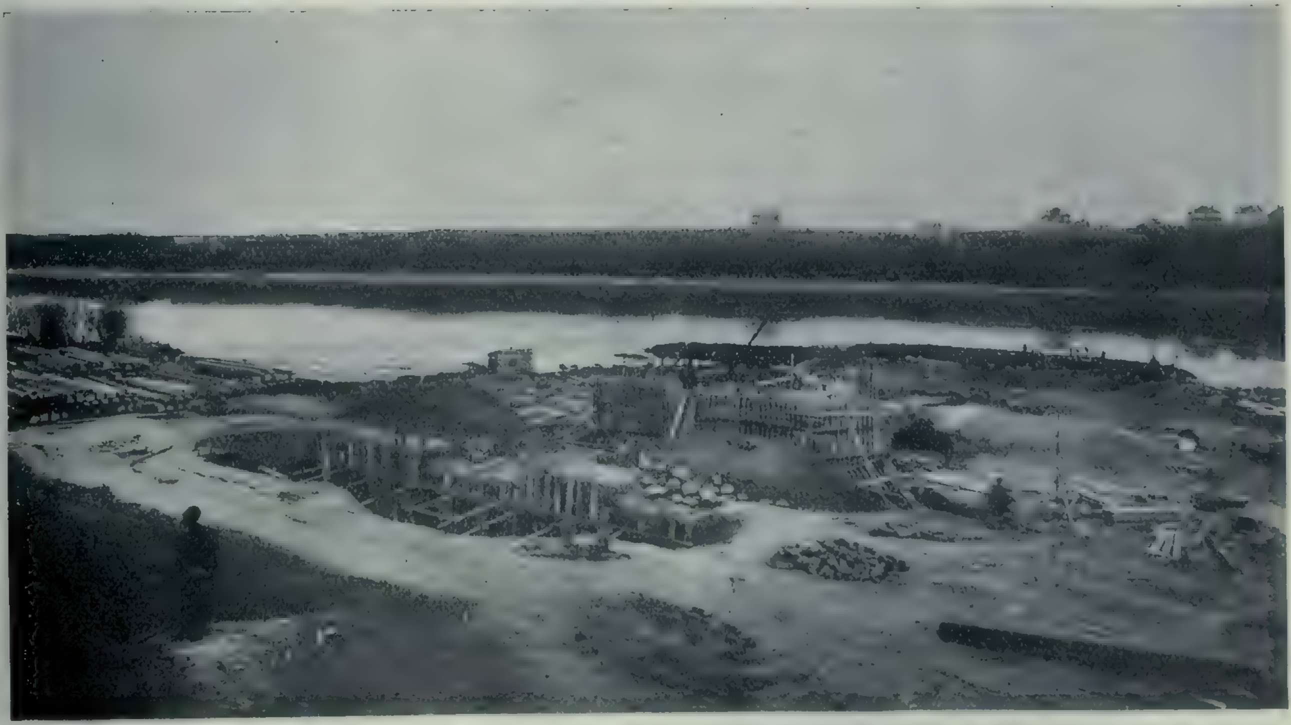
Barrington Bridge under construction, October, 1913, Barrington, Rhode Island.
Five spans of 55 to 60 ft. each.



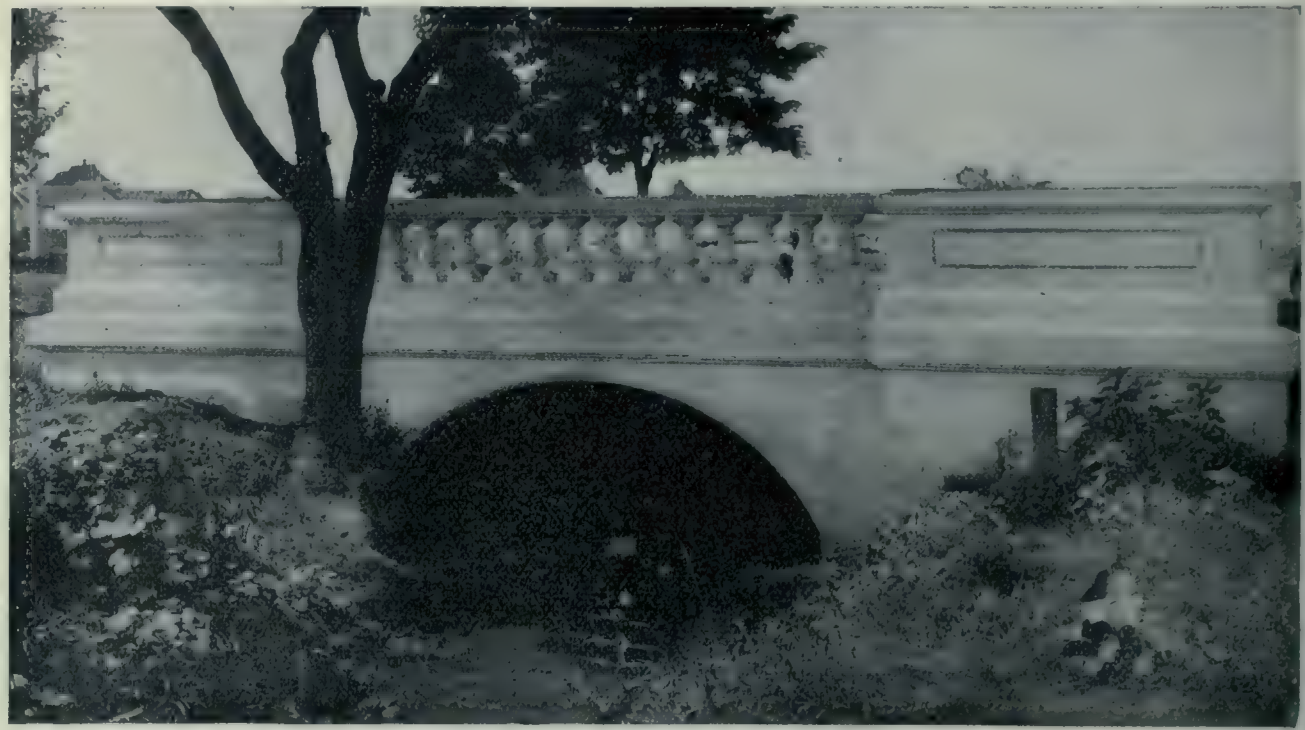
Stony Creek Bridge under construction, October, 1913, Orland, California.
Thirteen spans of 70 to 100 ft. each.



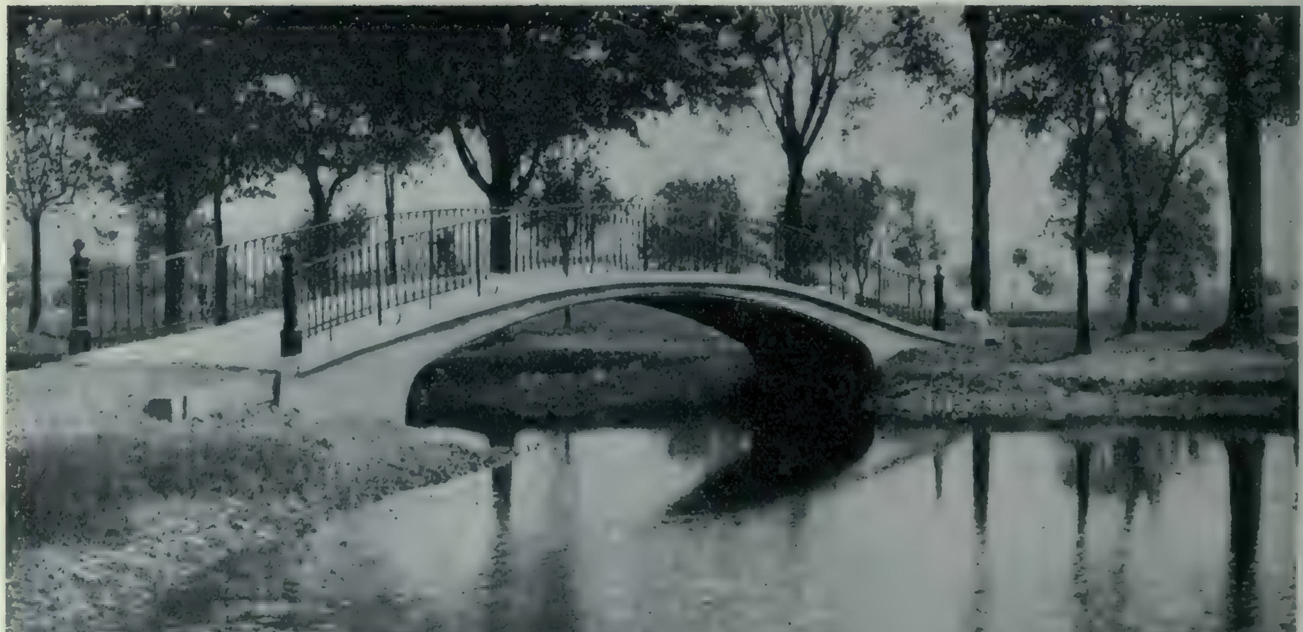
Hillsboro' River Bridge under construction, October, 1913, Tampa, Florida.
Three spans of 84 to 93 ft. each.



Saskatchewan River Bridge under construction, October, 1913, Saskatoon, Saskatchewan.
Ten spans of 25 to 150 ft. each.



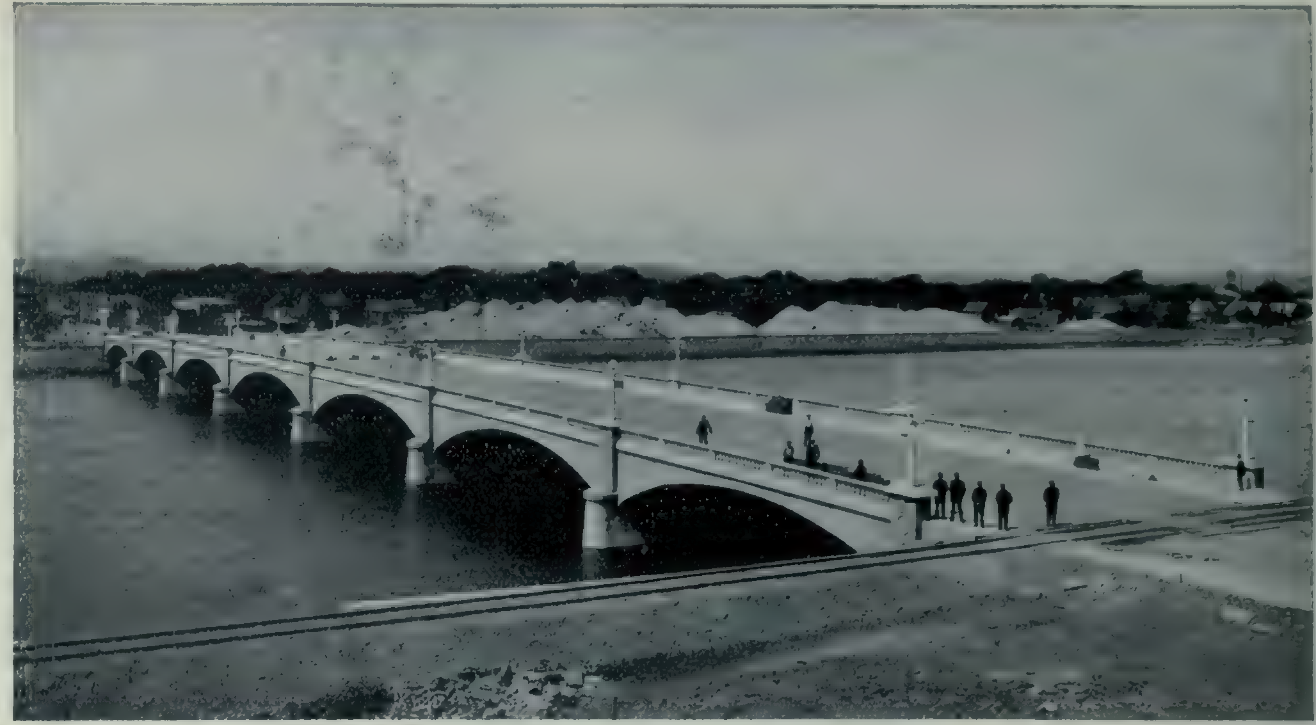
Concrete arch bridge, Des Moines, Iowa.
Span of waterway, 12 ft.



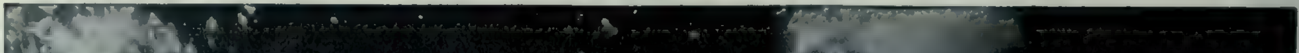
Concrete arch bridge, Columbian Park, Lafayette, Indiana.
Span of waterway, 40 ft.

Concrete arch bridge, Yorktown, Indiana
Span of waterway, 95 ft.

Concrete arch bridge over Maumee River, near Toledo, Ohio.
Twelve spans of 75 to 90 ft. each.



Concrete arch bridge over Grand River, Grand Rapids, Michigan.
Seven spans of 73 to 90-ft. each.



Concrete arch bridge, Lake Forest, Illinois.
Three spans of 45-ft. each.

investment. In the concrete arch bridge the only loss is that of the railings, which would perhaps be restroyed, and the side walls, which would be buried in the new fill. But this would doubtless be more than compensated in general by the fact that with the addition of increased width it is possible to produce a more ornate design than was originally contemplated. For it is usual at first to build even a permanent bridge as cheaply as possible. Hence earlier designs, although they may be dignified, are usually plain and lacking in ornamentation. But as a community grows older and learns to appreciate the beauty of permanent public works, well-designed and properly ornamented, the demand for handsome structures increases until even country highway bridges are surmounted by handsome railings of molded concrete balusters and massive end posts.

The concrete arch bridge thus provides all the qualifications requisite to an absolutely permanent bridge. Moreover, it is one of the handsomest bridges that can be designed and lends itself admirably to harmonious treatment for almost any location. It carries the roadway itself across the stream without any change in the road surface and even competes with temporary bridges in first cost. It is adapted to almost all spans up to 150 feet and by multiplying the spans can be adjusted to almost any location. It is the ideal highway bridge.

Practical Concrete Road Construction

POINTS of value to the concrete-road contractor brought out in a paper presented by C. D. Franks at the recent meeting of the Indiana Engineering Society are that forms for 800 lin. ft. of road will be required to handle the work properly on a 16-ft. road; that from 300 to 500 ft. of 16-ft. pavement can be laid in a day and the work will be delayed if 800 ft. of forms are not available; that the form setters should keep far enough ahead of the mixer so that the subgrade can be checked, and that for a large job it will be economical to protect the top of the forms with a metal strip.

A careful checking of the elevation of the foundation at frequent intervals of, say, 2 or 3 ft. by the use of a straightedge or string, resting on or stretched from the top of the side forms, and a rule is important in order to insure the proper thickness of the finished concrete. This may seem like an unnecessary requirement, but variation of less than 2 in. cannot, or will not, be detected by the eye. Failure to check the foundation as outlined will result in decreasing the thickness of the pavement at the center 25 per cent. or more where full strength is absolutely essential.

Mixing

The actual mixing of the concrete is of the utmost importance. Frequently, in practice, the time the materials remain in the drum is governed only by the speed of the gang charging the skip. At times the batch mixer is operated practically as a continuous mixer by fastening the discharge scoop or spout so that there is a constant flow of concrete from the mixer. Such a practice is a source of constant controversy between the inspector or engineer and the contractor. In all cases the drum should be completely emptied before the next skip of material is dumped into the mixer.

Other things being equal, the quality of the concrete is materially improved by thorough mixing. To insure this the speed in revolutions per minute of the mixer and the time the batch remains in the mixer after the water is added should be specified. To specify the one without the other is not sufficient, as is shown by the fact that on fifteen jobs the speed of the mixer varied from 7 to 32 r.p.m. and the time of mixing varied from ten seconds to two minutes, irrespective of the revolutions per minute. The drum speed should be about 16 r.p.m. for a minimum and about 21 for a maximum. The materials should remain in the drum at least three-fourths of a minute, and one minute would be better. Tests have shown that where concrete is mixed less than this time its strength is materially less than where the concrete is mixed three-quarters of a minute or more.

The strike board should always be worked forward about perpendicular to the axis of the roadway, and as it is moved ahead should be sawed back and forth across the road. At least two passages, and sometimes more, of the strike board over the surface will be required to produce a finish of the desired character.

When a concrete road has been laid in the late fall it is frequently difficult to determine when it will be safe to throw the road open to traffic. In some cases it may be necessary to open the road before the engineer in charge feels that it would be absolutely safe to do so. Under such conditions if about 3 in. of straw are placed on the pavement and this covered with several inches of earth the surface of the pavement may be protected sufficiently to allow the opening of the road a week or two sooner than could be safely done without such protection.

In discussing garbage disposal before the Cleveland Engineering Society recently, Mr. C. O. Bartlett stated that he believed his company had nearly perfected an economic system of garbage reduction adaptable to small as well as to large towns. Although not ready to give details, Mr. Bartlett outlined the process, as applicable to a town of, say, 5,000, as follows: Collect the garbage each day and place it in a steam-tight digester before it gets old and decays, and immediately cook or digest it. After digesting, steam press it down to about 50 per cent. moisture in the same digester, taking the water to a settling tank where the grease can be drawn off, saved, and the tank water passed to the sewer. Then dry the steam pressed tankage in the steam dryer down to about 12 per cent. moisture, which can be sold either direct to the farmers or to the manufacturers of commercial fertilizer. This is the simplest and best way that I know of. The principal object is to get the garbage into an absolutely tight receptacle and convert it into commercially valuable material.

An action brought against a Montreal woman, Dame Millette, to recover a penalty of $200 for unlawfully practising architecture was dismissed with costs, it having been shown that the lady had not made use of the word "architecture" although she had offered to supply details and plans for a consideration, such details being the equivalent of the ordinary specifications supplied by architects. The offer was made in a printed catalogue and in the advertisements published in the press. In the catalogue it was stated expressly that the firm had no connection with the Association of Architects of the Province of Quebec, hence the failure of the action.

The Special Application of the Various Roofing Materials

THE following data on roofing materials were taken from the report of the Committee on Buildings of the American Railway Engineering Association. In selecting a roofing there should be considered:

(1) Chance of leaks, due to character of construction.

(2) Probable life, including chance of damage by the elements and by wear from other causes.

(3) Fire-resisting value.

(4) Cost of maintenance.

(5) First cost.

The important materials may be classified as follows:

(a) Bituminous substances, applied with felts made of rags, asbestos or jute.

(b) Clay and cement products and slate.

(c) Metals.

As to manner of laying the roofing materials they may be placed in one of two classes: Materials for a flat roof, cemented together, as a coal-tar pitch-and-gravel roof or an ordinary tin roof; and materials for a steep roof, laid shingle fashion.

Bituminous Materials

The common bituminous materials are: Coal-tar pitch (the heavier distillates of bituminous coal); various asphalts (bitumens found naturally in the solid state); various petroleum products; and various animal and vegetable residues. Their peculiar value lies in the fact that they are practically insoluble in water, and that they are elastic, adhesive, and comparatively stable.

Coal-tar pitch is easily affected by heat and cold, is not acted upon at all by water, is easily worked, and, if properly protected, is very stable. It should ordinarily be used as it comes from the still "straight run," of a consistency suitable to the climate and to proper application. **Water-gas tar pitch,** a by-product in the manufacture of water gas, which is enriched by gas from petroleum oils, resembles coal tar. It is inferior to coal tar pitch for roofing purposes, and materials made from it should only be accepted in the low-priced products. It has more value as a saturant of felts than as a coating.

The **asphalts** are unsuitable for use in their natural state. They are ordinarily fluxed with products of petroleum.

The **petroleums** found in this country vary considerably, and grade roughly in quality, according to location from East to West. The California oils, with their asphaltic base, furnish materials especially valuable for roofing. The blowing of air through a heated still of certain petroleum products produces "blown oils," which, while somewhat lacking in adhesive properties, are not easily susceptible to atmospheric changes and are valuable especially for roofing coatings.

A single asphalt fluxed with a single oil is for most purposes a crude and unsatisfactory material. To secure the best results for any desired purpose, several oil and asphaltic substances must ordinarily be compounded. This requires skill and experience. Those properly made are for certain conditions invaluable, particularly for ready roofing, for which tar products are not suited.

The asphalt and petroleum products are not so readily affected by heat and cold as is coal-tar pitch, and lesser amounts of them are necessary to get good results. They are more expensive, require more skill in handling, and, when protected, some at least are to some extent liable to lose their life by drying out of the oil fluxes. Unprotected, they do much better than does coal tar.

Felts

The bituminous substances are used with felts whose qualities considerably affect the roofing. The ordinary felt is made of rags, mainly cotton. "Wool Felt" is a misnomer. Asbestos felts, as compared with the rag felt, act less as a carrying medium for the bitumens, but rather as a protection to the layers of bitumen. They are not suited for use with coal-tar pitch, but are not injured by hot asphalt. They are more expensive than rag felts, but have some peculiar and valuable qualities. Burlap made from jute decays easily when not protected. It is used in a few ready roofings, with rag felts, to increase their tensile strength, the need of which is not generally agreed to

Built-up Roofs

The bituminous roofings come ready to lay, or can be built up on the roof, using layers of saturated felt mopped with pitch, and properly protected.

The built-up roof is especially valuable for flat surfaces. It can be made as heavy as desired and if properly laid and of good materials it gives a roofing which by long experience has been shown to be economical and efficient. Where the roof is to be subjected to wear and where the character of the construction warrants the expense, flat tiles or bricks should be used as a protective coating to the roofing intsead of gravel or slag.

For the flat roof built under average conditions, coal-tar pitch is recommended in preference to asphalt products. It is more easily handled, requiring less skill, and while more material is necessary it is still cheaper, and in our opinion more certain results can usually be expected from its use when laid by the average contractor. The large amount of material, although heavy, has an insulating value. Good results, however, can be expected from built-up roofs using good asphalt compounds where laid by skilled workmen.

When the slope of the roof is over 3 ins. to the foot, the application of a built-up roof becomes more difficult for both coal-tar and asphalt, it being harder to get even mopping and there is more chance of accident for the men. The desirable straight run coal-tar pitch cannot be used, it being necessary to add some stiffening material which is supposed to affect somewhat the life of the pitch. This must not be done except under supervision skilled in such work, and especial care must also be taken in the selection and application of the stone or slag coating.

Built-up roofs with a ready roofing for the coating sheet are proposed by various manufacturers. They should have their best value for steep slopes.

The advantages of a coal-tar pitch built-up roofing are such that it is recommended where a permanent roof is desired and where the character of the structure allows the building to be so designed as to allow its use. A flat roof makes an economical structure and has small fire hazard. A pitch of from ½-in. to 1-in. to the foot is better than anything steeper. With proper materials and application a life of from 15 to 20 years can be expected with a flat roof.

No contracts should be made for a built-up roof without a complete and positive specification which includes flashings, and the contract prices should not be less than those of the materials specified plus a reasonable amount to cover the cost of laying and profit. Thorough inspection of workmanship and material is recommended.

Ready Roofing

The ready roofing has better value for the steeper roofs than for those of small pitch. It averages much cheaper than the built-up types. Most kinds to get a fair life require occasional recoating. For flat slopes they are hard to lay absolutely tight, and they are not economical for a permanent structure, but on slopes of from 3 ins. to the foot up their use is more justifiable.

Ready or prepared roofings are recommended for use on small, temporary and other buildings, where the cost, considering maintenance, of more expensive roofings is not justified. They are also of value for steep slopes where a built-up coal tar cannot be used, and for locations where the skilled labor necessary for a built-up roof is not available. The steeper the slope the greater their relative value and the wider their economical field. The heavier varieties are in general the more desirable because of their chance for longer life and their greater fire-resisting value. In making selections the reliability of the manufacturer, service tests and the cost should be governing factors.

On the steeper slopes the use of ready roofing shingles properly reinforced so as to prevent curling up at the corner and fraying on the exposed edges and laid shingle-fashion is growing. They are supposed to give better results than the rolled goods, but cost more. They would seem at least to be worthy of investigation.

Slate and Tile

Slate makes a good roof if of good quality and properly watched. It breaks easily and cannot be walked on without danger to the slate.

Tile of good quality gives good results. It is not so tight as slate, but does not break easily. It has architectural value, and its use is growing, with improvement in the product and in the variety of colors.

Slate and tile of suitable quality, properly protected and fastened, can be recommended on roofs with a pitch of 6 ins. to the foot or over, where expense is not the governing feature and where they aid in producing the desired architectural effect, except that where there is much chance of driving snow 8 ins. to the foot should be the flattest slope allowed.

Asbestos Shingles

Shingles of asbestos and Portland cement are of value. They have some elasticity and can be drawn down tight.

Wood Shingles

Wood shingles are not now desirable for a railroad structure.

Cement Tile

Small cement tile are not considered of much value, being brittle. Large cement tiles reinforced, laid without sheathing directly on the purlins are in use on shops and freight houses and seem to have considerable merit. Glass can be introduced into them, thus avoiding the expense of skylights. We are not ready to recommend them for plastered or heating buildings or offices where an occasional slight leak would be disastrous.

Metal Roofings

Metallic roofings with steel as a base are not recommended for general use on permanent buildings. They require continual maintenance.

Galvanizing of steel seems to be well worth the expense. Tests of lead covered steel sheets indicate good results. Large sheets of corrugated galvanized steel can sometimes be used economically where the building is not to be heated.

Small metallic shingles of either copper, tin, galvanized steel plate or specially pure iron are not recommended for general use. They are very light in weight and serve a purpose, particularly in the dry climate of the southwest.

In using metals, every effort should be made to secure those of good quality. The pure irons have value. Their virtues have perhaps been overstated, but they are not expensive, and experience seems to indicate considerable economy by their use as a substitute for wrought-iron and steel.

Copper, lead, zinc and Monel metal are used for roofing, but they are not of value for ordinary railroad structures.

General Comments

In the laying of all roofings thoroughness in the preparation of flashings and work around openings is of vital importance.

To get a satisfactory roof there must be a stable structure, careful attention must be given to the design of gutters, and with some types particularly there must be systematic inspection and regular repairs. In buying a roofing its fire-resisting qualities, to a considerable extent depending on the quantity of material as well as its quality, are of great importance. A building covered with a heavy coal-tar pitch-and-gravel roofing is a better fire risk than one covered with corrugated steel sheets, or with a light ready roofing. The practice of depending merely upon guarantees in selecting roofings cannot be trusted to secure proper results. It does not pay to put a cheap roof on a good building. The annoyance and indirect expense occasioned by leaky and short-lived roofs are rarely compensated for by any possible saving in first cost.

The contract has been awarded to Vancouver Island lumber firms to deliver to the order of the Dominion Government at Toronto 24,000,000 feet of timber to be used in the construction of the new harbor works at that city. Delivery must be completed within four years. A contract of this size is considered large in the lumber business, and the fact that it is the first contract to be placed as a direct result of the opening of the Panama Canal in the current year is taken as an earnest of the vastly increased trade for Vancouver Island to follow from that event.

Desirability of Co-Operation Between Architects and Contractors

By Charles A. Bowen[*]

THERE are many problems confronting the contractors and builders of the present day and while the methods and practices are largely improved from those of a few years ago, yet there are still in existence many of the problems which existed in the past decade which have been brought about by present-day conditions.

Building is one of the unfortunate trades in which an inexpert person is pre-disposed to believe that he knows quite as much as the expert, and while it is a fact that he generally knows what he wants, what he may be entitled to under the contract is often an entirely different matter and in this condition often lies the opportunity for arguments. As has been stated in previous articles, poor plans and specifications frequently handed the contractor upon which to bid for his work is a large problem, as is likewise a lack of skilled labor. Even these might be overcome if there was not such a lack of co-operation between architects and contractors.

The Lack of Co-Operation

This, it seems to me, is the largest problem which confronts those who are engaged in the contracting and building business to-day. There is no reason why there should be such a lack of co-operation between the architect and the contractor, for the source of their business and its existence is absolutely the same. The architect must have the contractor and the contractor, in most cases, must have the architect, while the work of each parallels that of the other. They are constantly in contact and the problems which confront the one, usually, are the problems which confront the other, and yet for some reason there is a woeful lack of co-operation between the two.

The architect is apparently imbued with the idea that the contractor is going to get the best of him and the contractor, on the other hand, seems to be imbued with the idea that the architect is trying to "put one over" on him, and instead of being upon a friendly basis where they can work in the greatest harmony to the best interests of their clients they are apparently, more or less, at swords' points. Whether this is the result of some peculiar make-up in the nature of the two, one being an artist and the other a mechanic, whether it is due to a lack of education along lines of compatability, or whether it is due to the condition of the time in which we live, it is nevertheless a most deplorable fact that this lack of co-operation exists.

There is, of course, unfair competition among and between architects as well as unfair competition among and between contractors, which is a great drawback to both of these important lines of a business which is one of the foremost of our modern times, and there is a large amount of unfair criticism by the general public against both contractor and architect which is entirely superficial and without foundation or sense. Yet it is thought by some of both profession and craft that a closer affiliation with each other would only strengthen in the minds of the public, the basis of this unfair criticism, that there was a collusion between them.

An Absurd Proposition

How absolutely absurd such a proposition or thought is may be seen in almost every building project, where this very lack of co-operation is shown by the troubles which arise, the disputes which have to be settled, the changes in specifications which have to be made, the large amount of "extras" which are necessary and for which the owner is held up on the work and which makes the cost more than originally intended or estimated.

Would it not be better to set aside public opinion which is as variable as the wind, and have closer affiliation between architect and contractor, so that these troubles and abuses might be overcome through conference and friendliness and the exchange of ideas and thoughts, and thus prove in a few short months that it was a most beneficial association in that better and more complete plans and specifications would be made, more understandable and equitable contracts drawn, better building done and at a lesser cost, and with less worry to the owner who is paying the bills, the architect who has drawn the plans and made the specifications and the contractor who is executing the work. I contend that it would, and I also contend that men brought in contact with each other in such a manner are more fair, more honest, more sincere and more considerate of each other, and that they do not stoop to underhanded methods or illegal or unfair combinations and collusions—in other words, are honest business men at peace with each other and the world.

Close Sympathy Between Architect and Builder

This is a day of co-operation; it is bringing about better results in every line of business and increasing individual efficiency. In a business of such importance as the building industry the closest sympathy and co-operation should exist between architect and contractor, who are both in the employ of the owner, to bring about the best results, not only for that owner who is pre-eminently entitled to it because he is paying for it, but for the benefit of the general public, the stability and beauty of our cities and villages and the general prosperity and solidity of our country.

Removing anchor ice from an intake pipe line of the waterworks at Moline, Ill., is accomplished by means of air, which is furnished by a Roots blower used in the washing of the rapid filters, according to a paper recently presented to the Illinois Water Supply Association by L. A. Fritze, chemist of the Moline Water Department. A 2½-in. pipe from the blower is tapped into the inner end of the 300-ft. length of a cast-iron intake line extending into the river. Ordinarily, a pressure of 10 lb. is used for the filters, but as high as 30 lb. are used to loosen the ice, which seems to collect around the unprotected end of the pipe and on the inside of it. The slight increase in temperature and the impact of the air were given as probable reasons for the successful clearing of the line.

---

[*] Secretary Detroit Builders' Exchange.

Technical and Economical Aspects of Road-Building in Quebec*

By Gabriel Henry†

IN this paper two of the principal aspects of the question of roads, the technical and the economical, will constantly be referred to. In the opinion of the author no sane conclusion can be arrived at without considering the question under the two principal aspects above mentioned.

The technical part is very important indeed, especially in new countries, but many millions have been wasted by neglecting the economics of road building. In the Province of Quebec for a long time, on account of its population being agricultural, and, at first scattered over a large territory, the question of a systematic improvement of roads was not an important consideration, each farmer maintaining, or rather being supposed to maintain, the portion of the road fronting his lot and some portions of the near by-roads. Of course at a certain distance from villages and cities there was no traffic worthy of mention.

It was only near the cities, where roads were badly cut up by the waggons of farmers coming to market, that the need of improvement was felt and turnpike roads were constructed. Until some years ago, this state of things had been the almost general rule in this Province, the farmers evidently not being much inconvenienced by it.

The growth of the population, its concentration in the cities, the advent of the railroads, the development of industry and the building of mills and factories even in the remote rural districts at last began to heavily tax the primeval roads of the country, and in many parts of the Province the population began to feel that something should be done for the improvement of highways. The advent of automobiles was the last blow to the indifference of the population in this matter.

Now, the problem to be solved is very difficult. The cost of construction, of improvement and of maintenance of roads is increasing every day and the construction of only the most needed highways will be a heavy burden on the population.

Classification of Roads

In the Province there are some 45,000 miles of roads and of "so-called roads." The "so-called roads," which in this paper will be considered as of the fifth class, are roads which have been opened in sparsely settled districts or remote parts of municipalities for the convenience of settlers. There is a considerable mileage of such roads in the Province, but the traffic over them is not worthy of mention. They require only a rough treatment as in the first days of the colony, and, in fact, are generally not maintained at all, the settlers nearby working form time to time on the worst parts in order to keep them open.

Next come the fourth class of roads and by-roads. The traffic on these roads is light as they are only used by the farmers living along them or in the neighbouring ranges, and they might be considered as second order arteries leading to the more important ones. They should be designated by the expression "earth roads," because for a long time to come they will not need a special surfacing and their maintenance as earth roads on account of their light traffic is preferable from the economical point of view. They only need to be graded, put in shape and maintained with split log drags. By means of them the farmers can communicate with the more important roads. The grading of these roads is, in numerous cases, beyond the farmer's means, being too costly. The author here is only making a rough classification of roads in order to render the following explanations easily understood.

Then come the third class roads, that is, roads with such a traffic that they are only maintained at great cost if a special surfacing is not provided. Generally, the waterbound macadam is sufficient and, automobile traffic being in fact light on such roads, other more costly surfacing would, all things considered, not be adapted to these cases. In this class are included portions of roads in the towns and villages where traffic is concentrated, parts of roads leading to railway stations, wharves and mills, or connecting some villages or towns outside of the provincial roads, and also some parts less frequented in the vicinity of cities.

Next, come the highways, properly so-called, which are known in this Province under the name of "provincial roads." They connect cities, or are important arteries leading to the United States, or following tracks along which industrial and commercial activities are concentrated and operated, or leading to the touring districts. These roads generally need special and more costly surfacing, if the economical point of view is considered, on account of the heavy traffic they actually bear or are supposed to have to bear in a near future, and, above all, because they are or will be much frequented by automobiles.

The last class of roads to be considered should be called "trunk roads." In the vicinity of the great cities many important roads of the above mentioned class meet at a certain distance, sometimes some miles from the heart of the cities. From these points to the cities run "trunk roads." These roads usually require to be widened and to have a special treatment of the substructure, a solid foundation and special surfacing, owing to the heavy traffic of steel tired waggons, automobiles, motor trucks, etc., to which they are generally subjected. It would be easy to prepare a list of the roads which, in this Province, have or will have in a near future what is needed in order to classify them as provincial roads, economically speaking.

Provincial Roads

The following list prepared by the author for the occasion is merely a general list of the roads which seem to meet some of the requisites of a provincial road. In this list they do not follow one another in accordance with their importance.

1. King Edward VII. Boulevard (constructed).

2. Montreal-Quebec road, via north shore (under construction).

3. Quebec-Matapedia road along the south shore of the St. Lawrence, via Montmagny, Fraserville, Rimouski, Sayabeck, St. Pierre-du-Lac, and along the Matapedia river to Matapedia and the interprovincial bridge between the Provinces of Quebec and of New Brunswick. This road would be very attractive to tourists.

4. The Montreal-Quebec road on the south shore, via Boucherville, Sorel, Nicolet and Levis. This road will be difficult of construction on account of the deep gullies it crosses along the St. Lawrence.

5. The Montreal-Ottawa road on the north shore, via Ste. Rose, Ste. Therese, Ste. Scholastique, Montebello, Pa-

---

*Paper delivered before The Canadian Society of Civil Engineers in Montreal on April 9.

†Chief Engineer of the Department of Highways for Quebec.

pineauville, Buckingham, Hull and Ottawa. This road will require a great deal of expropriation.

6. The Montreal-Ottawa road, via Ste. Anne-de-Bellevue, Vaudreuil and Riguard, along the Ottawa river. The greater portion of this road is in the Province of Ontario.

7. The Montreal-Toronto road via Ste. Anne-du-Bellevue, Vaudreuil, Les Cedres, Coteau Landing, St. Zotique, Pointe-a-Beaudet, along the St. Lawrence, with a branch leading to Valleyfield.

8. The road from Montreal to Malone, U.S., via Laprairie, Caughnawaga, Chateauguay, along the Chateauguay river to Huntingdon, and from that town to the frontier.

9. The Montreal-Sherbrooke road, via St. Lambert, Longueuil, St. Hubert, Chambly, Marieville, St. Cesaire, Abbotsford, Granby, Waterloo, Eastman, Magog and Sherbrooke.

10. A road from Montreal to Richford, U.S., via the foregoing to Chambly, and from Chambly to St. Johns, and probably Farnham or Bedford, Stanbridge, Abbots' Corner and the frontier. The location of this road will probably be difficult on account of the many municipalities wanting it.

11. The Montreal-Sherbrooke road, via Chambly, St. Cesaire, St. Hyacinthe, Ste. Rosalie, Upton, Acton Vale, Richmond, Windsor Mills and Sherbrooke.

12. The Montreal-Quebec road via Richmond, leaving the preceding one at Richmond and running via Danville, Warwick, Arthabaska, Plessisville and Levis.

13. The Quebec-Levis-Jackman U.S. road, via St. Henri, St. Isidore, Scott and along the Chaudiere river, via Ste. Marie, St. Joseph, Beauceville, St. Georges, St. Come, St. Theophile and the frontier. This road is to be constructed next summer.

14. The Sherbrooke-Quebec road, via East Angus, Dudswell, Marbleton, Weedon, Garthby, d'Israeli, and in the Asbestos Mines district, via Coleraine, Black Lake, Thetford Mines, Broughton, St. Frederic and meeting the Quebec-Jackman road at St. Joseph.

15. The Sherbrooke-Quebec road leaving the above-mentioned Sherbrooke-Quebec road at Marbleton and going to Quebec, via the old Craig's road, across the counties of Wolfe and Megantic.

16. The Sherbrooke-Derby Line U.S. road, via Lennoxville and Massawipi. This road will be constructed next summer.

Some exterior belt roads should also be mentioned, such as the road along the Canadian Northern, via L'Assomption, Joliette, Shawinigan, Grade Mere, Riviere a Pierre, St. Raymond and Quebec, and the road from Lacolle to Sherbrooke, via Henryville, Bedford, Stanbridge, Cowansville, Knowlton, Eastman, Magog and Sherbrooke. Certain cross roads between the principal provincial roads should be noted, such as a road between St. Hyacinthe and Sorel; Arthabaska and Three Rivers; Three Rivers and Shawinigan; Marbleton and Danville, via Asbestos Mines, Co. Richmond, etc. There are likewise some other roads, such as the belt road around the Gaspe Peninsula, the road between Quebec and Murray Bay, on the north shore, via St. Anne-de-Beaupre, St. Joachim, St. Tite, Baie St. Paul, Less Eboulements, St. Irenee, Murray Bay to Chicoutimi, via Ste. Anges, from Chicoutimi to Lake St. John and a belt line around Lake St. John. A road should also be constructed to the north of Montreal, via St. Jerome and Ste. Agathe to Mount Laurier. As examples of trunk roads may be mentioned the Chambly-Montreal, which is to receive the traffic of the two Montreal-Sherbrooke and of the Montreal-Richford roads; the Montreal-Ste. Anne-de-Bellevue, which is to receive the traffic of the Montreal-Ottawa and of the Montreal-Toronto roads; the Sherbrooke-Marbleton and the Montreal-L'Assomption roads.

In the opinion of the author the cost of such a system, the mileage of which is very considerable, would be so high and would so heavily tax the resources of the Province that the present generation cannot hope to see it completed, and the population of the Province of Quebec will have to wait many years before this system becomes justifiable and financially possible through the development of the country. It is hoped, however, that the roads most needed will be constructed in a few years.

The question which arises now is how and where to proceed in the improvement of the system of roads of the Province. The outlay will be very heavy and the monetary resources are comparatively limited. On the one hand the farmers from every part of the Province are asking for improvements of their roads which are much needed and are beyond their means. Everywhere are hills to be turned in order to improve impracticable and dangerous grades; low-lying places to be raised to avoid floods, which cause a great many roads to be impassable not only in the spring but frequently many times a year and do great damage to road beds; rocks to be mined, and bridges to be constructed; all improvements beyond the means of the municipalities, and a townsman can satisfy himself on that score by making a trip in the spring even to rural districts not far remote from cities. On the other hand automobilists are calling for provincial highways. To many the progress of the Province lies in the development of the latter kind of costly highways. the farmer's needs being set aside, or rather, ignored.

No thought is given by the public to the cost of maintaining roads. In the author's opinion the following should first be considered under such circumstances:—An outlay, which must be a paying investment should be made by the community. In order to obtain this not only the first cost of the improvement must be considered but the funds so invested must be protected from loss by waste and decay. The conclusions to be drawn from this are:—1. That no road should be improved without some provision for the maintenance of such road. 2. That all unprofitable work and works "de luxe" should be avoided within certain limits. 3. That all improvements not actually and positively needed should be omitted or postponed. As examples of such improvements the author may cite the adoption of costly surfacing for portions of roads where the traffic provided for will come at a later period, and all other unwise selections of surfacing either with a view to economize on the first cost or to display some luxury. 4. That the choice of some kind of pavement, the durability and ease of maintenance of which has not been ascertained in practice, be avoided as much as possible. 5. That unnecessary experiments be avoided. It is better to profit by experience obtained elsewhere and to make only those experiments which are absolutely necessary for adapting some good recognised product, process or method to local conditions.

Again, as the improvement of roads, like industrial or commercial investments, has to be a paying one, the sum invested should, in the author's opinion, be divided into three parts: one to be set aside for work which does not decay and can be easily and cheaply maintained without loss of value and for which a depreciation fund is to be provided; and a maintenance fund for annual repairs.

In the case of a macadamized road, for example, the cost of the earthwork, of the drainage and underdrainage and of the foundation should be considered as belonging to the first class, the cost of the surfacing to the second class, and to the third class the money required annually for maintenance.

Again, in the opinion of the author, there should be no hesitation in spending money judiciously and when needed for earthworks, underdrainage, ditches, substantial, well designed and well constructed concrete bridges and culverts, and good and appropriate foundations.

All money so expended adds value to the country, prepares roads for the surfacing, even when the latter is to be laid later, and is remunerative. Such kind of work well planned and well made lasts a very long time and requires little money annually for maintenance. On the other hand it is a waste of money to use costly wearing coats on a substructure not well drained or a water bound macadam on hills with a 10 per cent. slope.

How to Begin Improvements

Further, the author's impression is that the improvement of the roads of the Province of Quebec should be begun by preparing the substructure, lowering grades or rounding up hills, draining surface waters and underdraining ground waters, constructing bridges, straightening unnecessarily tortuous roads, maintaining these improved substructures as earth or gravel roads as the case may be pending the next step of the improvement, and the laying of surfacing. All this can be done economically. Surfacing should be used only when and where necessary. This mode of procedure would have a great advantage which is worth being insisted upon. Laying wearing coats on new fills not sufficiently settled, or on a new soil not sufficiently trampled by traffic nor well seasoned, accounts for many failures of good surfacings and for expenses of maintenance greatly exceeding the provisions. Quick work in road-making is not always to be recommended.

When the substructure of a road has been prepared and the foundation laid in advance, inconvenience is to be feared. Another occasional advantage is to divide the work. Contractors specialising in earthworks sometimes are not well acquainted with the laying of wearing coats, or have not at their disposal the skilled workmen required for such work, and the reverse is the case for surfacing contractors.

The author does not advocate the spending at present of all available money in preparing substructures of rural roads. Provincial roads are badly needed and for these the work must be pushed quickly; but stress must be laid on the advisability in many cases of preparing the substructure of roads in advance, and on the inconvenience of laying surfacing on improper and unseasoned substructures. There is no standard cross section for substructures of roads, but details should be standardized in accordance with the results furnished by experience. The width of 24 feet between ditches is not too great, but just what is needed for two wide automobiles or two hay waggons to cross each other, or a hay waggon to cross a wide automobile; for such cases plenty of room should be provided. It would be better to widen than to narrow the roads. When a horse vehicle meets an automobile, if the horses are nervous and deep ditches run alongside the road a traveller often feels that 24 feet is not too wide. This width should be reduced only in roads of secondary importance or when called for by special conditions. Even for roads much less important than provincial roads this width should be adopted if an increase of traffic is foreseen in the near future. In trunk roads the width between ditches may be increased if necessary to 32 feet or more and should never be less than 24 feet.

On embankments the platform should receive an additional width of 3 feet and have a total width of at least 27 feet from edge to edge, because the back of the guard-rail posts should be set at least one foot from the edge of the embankment. In cuts, generally, no ditches are needed and gutters prevail; consequently, the total width of the platform at the bottom of the cut can usually be reduced to between 26 and 28 feet for a 24-foot wide road. The edges of the embankments should be bevelled or rounded when the engineer has to deal with a clay soil, in which case it is useless to try to get sharp edges. The slopes along the embankments and cut should generally be 1½ horizontal to 1 vertical, but engineers may avail themselves of the nature of the soil if well acquainted with the natural slope of one particular soil. In this country it is necessary to avoid cuts on account of the snow, which, in winter, fills them and renders the road impracticable.

If the road is to receive its surfacing later, it should be given a transversal crown of at least 1 inch in the foot in order to shed the rain-water into the ditches and to allow maintenance with split-log drags. If the road is to immediately receive its surfacing, shoulders at least 4 feet wide should be provided. The slope of these shoulders towards the ditches should be at least 1½ inch to the foot.

Such are the principal features of a cross section of the substructure.

For the execution of the earthwork the same rules are to be followed as in the case of railways. For shrinkage the rates of fills to cuts comprise between 1.15 and 1.30—1.15 being for heavy work and 1.30 for light skimming work.

The Rolling Grade System

In the author's opinion the rolling grade system with vertical curves should be adopted; because it is more economical and facilitates the drainage of the substructure. It is useless to try to get at great cost long stretches of horizontal road. The maximum ruling grade should not be more than 5 per cent. whenever possible, 6 per cent. and 7 per cent. grades being resorted to only in short patches when absolutely imposed by necessity. A waterbound macadam is maintained only at great cost in this country on grades of 7 per cent. and more, and on account of the snow filling the ditches in the spring, water from melting snow, in many places, injures the roads. The same holds for earth or gravel roads. It is better to try to get 5 per cent. by turning around hills when improving a road than by cutting them too much. Minimum grades should not be less than 0.6 per cent. to ensure the longitudinal drainage of the road.

Curves having a radius less than 300 feet should be avoided in steep grades and at the foot of such grades, and a radius less than 200 feet should always be avoided even in flat stretch. When it is necessary to adopt a radius less than 200 feet, the road should be widened in the curve and be given a transversal slope towards the centre of about 1 inch to the foot.

The end or the beginning of a slope should not be found at a distance less than 50 feet from a level crossing of a railway or from the end of a bridge. Sight distance in horizontal or vertical curves should be at least 300 feet, depending in each case on the conditions. Near a railroad crossing the sight distance on each side in the direction of the track should be at least 3,000 feet.

In every case, the economy of grading should not be the controlling factor. The most important considerations should always be kept in mind in determining the profile and the cross sections. The standards can be used as general guides, but good common sense and acquaintance with local conditions should have much to do with it.

The earthworks are computed as for railways, but for roads greater exactitude is needed because in this case they consist chiefly of skimming work, ditching and shouldering, which cost more per cubic yard and are more difficult to estimate exactly.

Draining Soil Important

The draining of the soil is the most important thing in road construction, because the bearing power of the soil depends upon the moisture it contains. In this country this question is far more important than in the southern countries, owing to the nature of the climate.

The soil is soaked by rain-water and by ground-water. The rain-water should be disposed of as quickly as possible by a good, substantial system of ditches, gutters and culverts. Deep ditches should be avoided as much as possible and gutters substituted. Deep ditches are only necessary along flat stretches of road in order to get the necessary slope to cause a quick and complete drainage of water. The minimum slope to be given to ditches should be 5 inches in 100 feet. Stagnant water should never be found in a ditch.

The greater slope depends upon the resisting power of the soil to abrasion by water and should never exceed such power.

The slopes of the sides of the ditches should be regular and as nearly as possible 1½ foot horizontal to 1 foot vertical. It is very difficult to attain this in a flat country where ditches have sometimes to be very deep and wide and would exceed the portion of the right of way that it is possible to set apart for them. In such cases rip-raps have to be resorted to. Gutters along hills should be paved with cobble stones whenever the soil is not hard enough to resist abrasion by running water.

Tile underdrainage with good outlets is generally to be preferred to deep ditches for disposing of the ground water. Road underdrainage should be made in the same way as in the case of field drainage. Tiles should be laid under the sides of the road rather than under the centre, and should be disposed so as to intercept all water coming from the neighbouring fields before they enter the right of way. It is important that good and frequent outlets should be provided. Underdrainage, in order to be a permanent and useful work, should be done with the greatest care. It is very difficult to drain a road effectively and completely, and in many cases it is impossible to get the ground water out. Generally, although the soil is dry, its bearing power is not great enough to stand concentrated wheel loads and it is impracticable to sufficiently consolidate it; sometimes a sufficient and effective underdrainage is impossible, and then it is necessary to resort to the use of a foundation in order to distribute the concentrated wheel loads over a wider surface.

The Foundation

The foundation plays the same role in the case of roads as ballast in the case of railways. It is generally assumed that the downward pressure follows a line at an angle of 45 deg. from the horizontal and is distributed over an area equal to the square of twice the depth of the total thickness of the surfacing and of the foundation. This is merely an assumption but it is approximate enough in practice, and it has been found that the thickness of the foundation plus the thickness of the surfacing should not be less than 9 inches in common soil for steel tire traffic.

A non-porous soil drained of ground water will support a load of about 4 pounds to the square inch, that is, about 1,300 pounds per square inch applied to the surface of a coating 9 inches thick, per lineal inch of waggon tire. In practice a load of 700 to 800 lbs. per lineal inch of tire is assumed, that is, 2 to 2½ inches per square inch on the substructure with a 9-inch thick surfacing including the thickness of the foundation.

Many good surfacings give bad results owing to the lack of a substantial foundation. For a soft tire traffic a foundation is not so necessary as for the traffic of waggons with narrow tires and without springs, the impact of which is very damaging to roads.

The foundation should be composed of stones not larger than 4 inches, and a filler in the voids is to be recommended whenever it is not very expensive. Gravel, as in the case of the railways, gives a good foundation and is even better than stone. Telford foundation should be resorted to only in case of necessity. Flat stones should not be used.

Foundations are of the class of permanent works mentioned above. Bridges and culverts should also be so constructed as to be considered worthy of the same class.

Good concrete is well adapted for this kind of work. Concrete pipes should not be used in naturally wet clay soils, especially under heavy embankments. They should be of ordinary thickness and of a diameter not larger than 30 inches under embankments higher than 14 feet. In these two cases box culverts would be preferable. Sand cushions should be employed to protect them against rock. It is absolutely necessary to give the head walls a firm seat, especially in clay soils and when the pipes are under an embankment. Concrete slab bridges are very useful as well as concrete girder bridges. The maximum economical span of a slab bridge is about 15 feet and of a girder bridge between 15 and 30 feet or more. Under high embankments arch culverts should be used.

Concrete trestle bridges are especially recommended for use on rivers where numerous deep gullies are found, as this type of bridge spans them very economically and artistically, thus dispensing with heavy embankments and deep cuts. The latter ought always to be avoided in this country on account of snow.

Many difficulties are encountered in this Province, as elsewhere, in fixing the dimensions of the culverts because the road engineer has, when deciding, to deal with the farmers. The same difficulties are met with when straightening tortuous, crooked roads and improving curves. These difficulties are not technical but are of common occurrence in all countries, being unpleasant and unavoidable. The greatest care should be taken in the planning and construction of bridges and culverts for which the same general rules have to be followed as in the case of railways and of first class concrete work.

The cost of the permanent work, that is, of the part of the outlay permanently invested in the case of roads, is a smaller fraction of the total cost than is generally supposed. Except in special cases, it never exceeds one quarter or one third of the cost of the surfacing proper, and in the case of special wearing coats this proportion is still smaller; consequently, great care should be taken in the choice and the laying of this part of the road which is short lived and so expensive.

Some Points to Consider

The following points should be taken into consideration when making a choice:—

1. Not to attempt to risk surfacings on a substructure which is not sufficiently firm with or without foundation. Waterbound is not excepted.

2. Not to use surfacing in places where floods or other causes could damage same.

3. Not to use costly surfacing when a less costly could reasonably do as well for the number of years the latter is supposed to last.

4. Not to use costly surfacing when the amount of the total sum of the first cost of the sinking fund and of the maintenance of the said surfacing is higher than with a less costly wearing coat which would do as well.

(Concluded in next issue.)

The City Council of Fredericton, N.B., appear to be undecided as to whether they will engage an engineer, notwithstanding the recommendation made some time ago by Mr. F. A. Barbour, consulting engineer, that for the filtration plant an engineer who is thoroughly familiar with the work should be placed in charge. Three applications have been received for the position but the matter of appointment has been deferred for the present.

Two men were killed, one fatally and five seriously injured by the collapse of the west wall of the Independent Cloak Company's building, Toronto, which was burned down a short time ago. All the victims were workmen who had been inside the building clearing away the debris.

LETTERS

"Fish of One Contractor, Flesh of Another"

Editor Contract Record:

I am heartily in accord with your article, "The Curtain Raised on Toronto's Fire Tragedy," published in your issue of April 8, but feel, with others, like saying, "What's the use?"

It is a well-known fact that the recent investigation into the Toronto City Architect's Department was not brought about by the desire of the city council to make an improvement but because of a disagreement between certain factions in the council over the appointment of a City Architect.

All the points brought out at the investigation have been known to many citizens for years. During that period, while few have had any grievance against individuals in the Department, collectively it might be compared to a ship without a rudder.

The many improvements and suggestions that have been made by the Bureau of Municipal Research have been opposed by the civic employees, and those in high authority have rushed to the defence of the heads of the department.

As to the excessive requirements contained in some sections of the building code, personally I do not advise reducing the factor of safety, particularly in these days of "Safety First," but would demand that all classes of builders be compelled to live up to the by-laws, and not make fish of one and flesh of another.

Time and again it has been shown that certain persons, with what is commonly called "pull," can get away with a class of construction that the less fortunate one could not attempt. Even the civic employees break the city by-laws. Recently, to my knowledge, the city demolished a building which belonged to them without erecting a hoarding. Simply a rope was tied from pole to pole and a man placed on guard to warn the people to walk in the middle of the road—which, by the way, has car tracks—thereby endangering the pedestrians' lives. Any contractor would be glad to save fifty dollars, the possible cost of a hoarding, but he would probably end in the Police Court.

Yours truly,
"Contractor."

"The Time Is Ripe"

Editor Contract Record:

Having read with interest the report of Judge Denton upon the Toronto City Architect's Department, I take pleasure in adding a few words of commendation on the manner in which the "Contract Record" has undertaken to enlighten the public regarding the true conditions of the way in which work has been handled under the City Architect's Department.

That discrimination has been rife is the experience of all who have had dealings with the Department. This discrimination, or to put it in a milder form, this lack of uniformity in handling the work, led to the organization of the Citizens' Committee, whose object was to prepare a by-law which would be up-to-date and to which all would be made to conform.

That the old by-law was faulty and rotten to the core was acknowledged by all, and in many instances the interpretation was worse than the by-law. So strongly was this felt by architects, engineers, contractors, the Board of Trade, the Canadian Manufacturers' Association and others, that a committee was organized and sub-committees composed of members of each of the above-named bodies were appointed. These sub-committees devoted two and three nights a week for a period of some four months to a perusal of the old by-law, correcting and replacing the faulty and obsolete portions. After the various sub-committees were satisfied with their revisions many joint meetings of the committee as a whole were held and the entire by-law was discussed many times, this resulting in the Memorial as presented by the Citizens' Committee to the Council.

The result of this general agitation led to a new by-law being issued, which, while not conforming in all points to the Memorial presented, was a decided improvement over the old one, and would be much better if it were carried out, instead of exceptions being made either by the influence of the Controllers, the Board of Control, the Fire and Light Committee or by the Department itself.

That the time has come for all plans to be examined by men specially qualified in each case to deal with the specific types of construction and that all inspectors of construction should be the best men obtainable is evident. In the writer's opinion the complete organization of a new department under a capable head, with a staff qualified in the branches to which they are assigned, is a necessity.

Should there be organized such a Department, having full jurisdiction over all plans, permits, etc., and whose decision would in all cases be final, with no appeal to the Council or Committees, not only would the safety of the public be protected but all plans would be dealt with on their merits and not according to the influence which might be brought to bear from the powers above. If a change is to take place I say that the time is ripe.

Yours truly,
T. Harry Mace.

The Organization of Engineering

A letter relating to the above topic, discussed editorially in the Contract Record of March 4th, was received from Mr. R. W. Macintyre, M. Can. Soc. C. E.,* and published in our issue of April 1st. Mr. Macintyre's letter was a particularly able presentation of the views accruing from a ripe experience of engineering work, and we regret to find that owing to a printer's error a line was omitted in the final paragraph of the communication. The concluding lines should have been expressed thus:—

> "I can only say, in conclusion, that we must break loose from the 'mutual admiration attitude' mentioned by Mr. Shenton in his address upon which your editorial was based. This attitude is sapping the vitality of our progress. We must be prepared to take and give the hard knocks which always accompany genuine reformation."

In his letter, Mr. Macintyre attributed the present lack of cohesion in the engineering profession to the apathy of the rank and file and the defective organization of the Canadian Society of Civil Engineers.

In a further communication Mr. Macintyre offers the following supplementary observations, which offer food for careful reflection:—

"Too frequently one is met by excuses in place of action and I am confirmed in my view that the 'individual equation' forms the keystone of all potential reform.

"'Close corporation' will never effect a remedy, as it affords a shield behind which the incompetent can enjoy security with the competent member, and, like most other forms of protection, often has the effect of enriching a favored few at the expense of the community, by 'sandbagging' the stimulus of legitimate competition.

---

*Secretary, Victoria Branch, Canadian Society of Civil Engineers.

"The close corporation granted to other professions does not always guarantee satisfactory results to the public when employing professional service, and we again revolve to the starting point, of individual ability selected from personal experience and judgment.

"It must be borne in mind, however, that a certain section of the public consider the cost rather than the quality of professional service paramount, and this is where the cheap man gets his foothold. This phase of the question being beyond legislation resolves itself into a matter of education.

"If every practising engineer had to be registered with the government and registration were made consistent with the professional qualifications established by all recognized engineering societies, the initial difficulty of amateurs posing as professionals would be practically eliminated. A concerted effort in this direction should be undertaken without delay."

R. W. Macintyre.

Building Activity in Montreal and District

Several large buildings will be erected in Montreal and district this season, but indications point to chief activity in the construction of residences. The demand for office buildings has been fairly met, and the permits taken out show that there will be very little work of this character, except for special purposes. Thus the London, Liverpool & Globe Insurance Company will erect a large office on Dorchester Street, from designs by Nobbs & Hyde and J. Rawson Gardiner. The Bank of Toronto intend to demolish their present building at the corner of St. James and McGill Streets, and construct a ten-storey building on the same site, the plans having been drawn by Hogle & Davis. The ground floor is to be used for a banking room, which is to be sixty feet square, and the upper floors for commercial and financial offices. The frontage on St. James Street will be 90 feet and on McGill Street 60 feet, the main entrance being on the former thoroughfare. A new building for the National Trust will go up on St. James Street.

Probably the greatest amount of money will be spent on churches and schools. Messrs. Viau & Venne are drawing plans for a very fine church to replace the St. Joseph Oratory, on Mount Royal, which will have a seating capacity of 2,500, and will be the largest church in the city. One of the most important Anglican churches, St. George's, is to be built from designs by Barott, Blackader and Webster. The interior length is 185 feet; the breadth, including the side aisles, 50 feet; the chancel 52 feet in length, and the height of the nave 65 feet, while the main tower will rise 120 feet above the ground. The main and solo organs will be placed in the chancel. The church will be connected by cloisters to the school house and rectory. It will be constructed of Indiana limestone. The church will be on Dorchester Street West, and the nave and tower are to be on the axis on Bishop Street. A fine college is to be built by the Loyola College at Notre Dame de Grace, the architects being Messrs. Peden & McLaren. The cost is estimated at $400.-000. Another college is to be constructed in St. Lambert, from plans by Viau & Venne, at a cost of $175,000. Messrs. Beauregard, Champagne & Chenevert have designed two churches, one to cost $250,000, on St. Urbain and St. Viateur Streets, and the other to cost $150,000, on Fullum Street.

There are reports of two or three schemes for new theatres, but the only one which is certain is for a Jewish theatre on St. Lawrence and Duluth, planned by Mr. C. Dufort. A large hippodrome, however, is to be constructed in Maisonneuve. Several substantial factories will be erected, including buildings for the Simonds Canada Saw Company and for the United Shoe Machinery Company of Canada, the latter in Maisonneuve, both contracts being let to C. E. Deakin, Limited. The Tuckett Tobacco Company are also erecting a factory.

Some important buildings will be completed this season. One is the new office for the Sun Life Insurance Company, and another the immense factory of the Imperial Wire and Cable Company, now incorporated with the Northern Electric Company. Great progress has also been made with the new customs warehouse on McGill Street, the foundations for which were put in by the Foundation Company. The general contractors are the Peter Lyall & Sons Construction Company.

From returns received by the Quebec Mines Branch from the producers it is learned that the value of the products of the mineral industry of the Province of Quebec in 1913 total $12,918,109. The mineral production of the Province for 1904 was $3,023,568.

On the recommendation of the Faculty of Applied Science, McGill University, it has been decided to take steps to lengthen the course of architecture from four to five years, commencing with the session 1914-15.

Mainly Constructional

East and West—From Coast to Coast

EASTERN CANADA

The Skootamatta Power & Development Company, Limited, has been incorporated at Hamilton with a capital of $300,000.

The Chatham town council has postponed the appointment of a building inspector pending the preparation of a building bylaw.

One of the large fires of the past week was the new summer hotel of the C. P. R. at St. Andrews, N.B. The damage is placed at $500,000.

Mr. W. Grayson Brown, of Hamilton, is the architect for a three-storey brick apartment house to be erected in that city at a cost of $125,000.

At Charlottetown, P.E.I., work is proceeding on a $200,-000 church for St. Dunstan's R. C. cathedral. The contractors are Messrs. John S. Metcalfe Company, of Montreal.

The foundations are in for a new school building which the R. C. School Commissioners are erecting at Quebec at a cost of $200,000. The architect is Mr. R. Lemay, of Quebec.

The roof of the mixer of the new blast furnace at the plant of the Dominion Iron & Steel Company, Sydney, N.S., fell on April 13, crushing four men who were working in the mines at the time.

A committee representing the contractors of Fort William and Port Arthur have arranged to meet a deputation of the bricklayers of the twin cities for the purpose of arranging a wage schedule for the coming building season.

A call for tenders is about to be issued in connection with the office building which the Liverpool, London & Globe Assurance Company are erecting at Montreal and for which Messrs. Nobbs & Hyde, of Montreal, are the architects.

Excavation is proceeding on the addition to the buildings of the University of Ottawa, which is being made at a cost of $150,000. The architect is Mr. C. P. Meredith, of Ottawa, and the general contractor Mr. C. E. Deakin, of Montreal.

Plans have been prepared and accepted for a hydro-electric plant at Lake Megantic, Que., estimated to cost $150,000. The engineer-in-charge is Mr. E. A. Evans, of Quebec City.

Frasers, Limited, who operate a large lumber mill at Fredericton, contemplate erecting a large number of model working men's houses during the coming summer for their employees.

Messrs. Horwood, Taylor & Horwood are the architects for a store and apartment building on Rideau Street, Ottawa, upon which excavation work is now proceeding. The estimated cost is $180,000.

The Kennedy Construction Company, Montreal, have been awarded by the C. P. R. the contract for extending the present masonry abutments and piers in concrete on the Humber River, Ontario.

Mr. J. R. W. Ambrose, chief engineer of grade separation of the G. T. R., has been appointed chief engineer of the Toronto Terminals Railway Company, which will build the joint C. P. R. and G. T. R. station in Toronto.

An echo of the Woodbine Hotel fire tragedy at Toronto is heard in the announcement that Mr. F. H. Herbert, of that city, is preparing plans for a new 10-storey hotel building, of fireproof construction, estimated to cost $250,000.

Tenders are being called for the construction of a new lower grade school building at Fredericton, N.B. The estimated cost of the new building is about $30,000 and it is expected to have it ready for occupancy this year.

Work has been resumed on Fredericton's new Post Office. This building will call for the expenditure of over $300,000 before completion. It is steel frame with free stone body. The old post office will be transformed into a Customs House.

A street and domestic lighting system is to be installed at Beloeil, P.Q., at a cost of $20,000. The scheme includes the construction of a transmission line five miles long, the lamps being placed on cedar poles at distances giving 42 lamps per mile.

Building activity in St. Catharines so far this year promises to exceed all previous records. The returns for March show that permits to the value of $110,975 were issued by the city clerk as against $41,730 in the corresponding month last year.

Messrs. Brunet & Leclerc, of Lachine, have the contract for a college at St. Lambert, Que., estimated to cost $150,000. Messrs. Viau & Venne are the architects. The new building will be three storeys high, of fireproof construction, and will cost $150,000.

The building outlook for Toronto this year is summed up by contractors generally as being much more promising than last year. Industrial activity is everywhere apparent and the brick yards in and around the city are producing in the neighborhood of a million bricks a day.

Upon the completion of the new annex to the Provincial Normal School, Fredericton will be credited with having the largest educational building in New Brunswick, if not in the Maritime Provinces. The recent addition to the Normal School cost in the vicinity of $50,000.

At Maisonneuve, Que., the United Shoe Machinery Company are to erect a new factory at a cost of $300,000. The building will be two storeys high, 164 ft. by 140 ft. in dimensions, of brick construction. The general contractors are Messrs. C. E. Deakin, Limited, Montreal.

A 50,000 volt transmission line from Richelieu to St. Hyacinthe, P.Q., is being constructed by the Southern Canada Power Company, which recently acquired power plants at St. Hyacinthe and St. Johns, and water powers near Drummondville. It is intended later to extend the line to Sherbrooke and link up the various plants into a complete power system.

The city of London, Ont., is advertising for tenders to carry out a large scheme of storm sewer construction. The work will comprise 9.14 miles of city mains and 2.66 miles of connections to catch basins. Messrs. Chipman & Power, Toronto, are the consulting engineers and Mr. Wm. N. Ashplant, City Engineer, is in charge of the work.

In the architectural competition conducted by the government with regard to plans for the new supreme court building at Ottawa, six preliminary designs have been selected out of a large number submitted. The choice was made by a board drawn from among the officials of the department of public works. The final decision will not be announced until early in September.

The main building, ten storeys high, of the new sugar refinery at St. John has been erected, and rapid progress is being made on the other buildings making up the complete plant. The new refinery on one side and the new C. P. R. grain elevator on the other stand as sentinels at the mouth of the harbour, indicating the industrial and commercial importance of St. John.

It is expected that new tenders will be called for the heating of Howick Hall, the building within the Central Canada Exhibition grounds, Ottawa, which was partially wrecked by explosion some time ago. The objection to Mr. H. A. Knox's tender, which was the lowest, was that it was not opened until the figure of the other persons tendering had apparently been made known.

The Government has not yet decided as to whether there will be any legislation passed this session on the report of the Highway Commission on good roads. For the coming season at least the department of public works will adopt the suggestion of the Commission in encouraging, as far as possible, the continuation of the work by the counties under the Highways Improvement Act.

A carload of ore from what is called the Cobbler-Sexton mine near Woodstock was sent to New York a few months ago to be assayed. It is said that the ore is sufficiently rich in gold and copper to warrant the development of the mine, and word comes from New York that a smelter and concentrator will be installed, and in the neighbourhood of half a million dollars spent by a new company which will take over the property.

After several months of preparation, work was commenced on April 16 on the reconstruction of Toronto harbor. Operations were begun on what is known as the northern slip at the foot of Cherry street, the object of this work being the reclaiming of a large area of land for industrial purposes. It is proposed to enlarge Keating's channel from its present width of 80 ft. to 120 ft. The Canadian Stewart Company are the contractors.

Building statistics showing records of houses erected since 1862 and the values from 1884 have been compiled in the building inspector's department at Montreal. In 1884 a total of 317 houses built represented a value of $1,014,015. With valuations varying slightly the period from 1897 to 1909 was marked by a steady increase, values in the latter year being $7,785,621, and for the year 1912-13 an increase of nearly $8,000,000 was shown. The year 1913 shows a total of 3,794 houses, representing a value of $27,037,097.

The concrete work at Cote St. Paul locks of the Lachine Canal has been completed by the Government engineers and the sluice gates placed in position prior to the opening of navigation. The work being carried out by the Government is not merely the construction of a new power house but the excavation and opening of a new inlet to the Canal for the purpose of supplying more water. The entire work will cost upwards of $300,000. About 100,000 cu. yds. of earth will be excavated in removing the curve in the vicinity of the locks.

A company known as Concrete Builders', Limited, has secured a building at Gibson, opposite Fredericton, and is installing machinery for the manufacture of marble-faced pressed brick, ornamental cornices, pressed brick, water pipes, tile pipes and concrete blocks. The gravel for use in the factory will be dredged from the bed of the Nashwaak River. The directors of the company include Hon. H. R. Emmerson of Moncton; Hon. J. P. Burchill of Nelson; T. C. Burpee; J. J. McCaffory and other well known citizens of Fredericton.

Representatives of the contracting firm of Messrs. Jos. McVey & Son, Mr. A. R. Wetmore, chief engineer of the public works department, Mr. Springer, resident engineer, and representatives of the city and county of St. John, N.B., interviewed the government a few days ago in connection with the construction and substructure of the new bridge across the reversing falls at St. John. It was stated that owing to difference of opinion between the contractors and engineer Springer work had been delayed, the contractors refusing to carry out the engineer's orders. The department of public works will deal with the matter and see that the work is expedited.

The Montreal Board of Control in their report on the recent investigation into the break in the civic water supply conduit last December, place responsibility on the Cook Construction Company, the contractors, but recommend further examination of plans to decide this point with greater certainty. They believe that contributing causes of the break were, "too close proximity of excavation, method of excavation employed, and weakness of the conduit itself." Suspension of work until plans for widening the aqueduct can be thoroughly examined is recommended. The investigation, which lasted about three weeks, was mainly devoted to taking expert testimony.

In addition to a large amount of government work, particularly on the harbour, at Quebec, a fair amount of building is either being carried out or is contemplated. The Bank of Montreal have purchased a site for a new branch at the corner of St. John Street and Palace Hill; C. W. Lindsay, Limited, will put up a five-storey building on St. John and Eustache streets; and the Good Shepherd Nuns will construct a school costing $250,000. The Post Office is also to be extended. The Canadian Stewart Company, Limited, have just completed for the Harbour Commissioners a million bushel elevator. This is situated on the Louise Docks and is constructed of concrete.

The "model city" at Montreal, which has been planned for the Canadian Northern Montreal Land Company, to be located on the further side of Mount Royal, received its charter in January, 1912. All the streets radiate from a central spot which is designated Connaught Square, around which will be situated the public buildings for the government of the town as well as the station of the Canadian Northern Railway, whose great tunnel scheme has rendered possible the realization of the project for utilizing the land on the further side of the mountain. It is said that the business streets will be at least 80 ft. wide and the residential streets 66 ft. wide with strips of grass on each side between roads and sidewalks. Fifteen miles of road have already been constructed and the work is progressing speedily. The requirements in regard to building are that all houses must be built of solid brick, concrete or stone, or be encased in brick.

Mr. J. Norton Griffiths, M.P., cables from England that two more dredges are on the way to St. John, N.B., and that another will be sent forward immediately to join the fleet now engaged in dredging Courtenay Bay, the new eastern harbour of St. John. The channel must be dredged into Courtenay Bay, and the basin dredged out inside the great new breakwater which is being constructed. The Norton Griffiths Company have given assurance that the work of dredging, building the breakwater, constructing the dry dock and the first of a series of wharves will be completed within the contract time, and this means great activity at the site of these immense harbor works. At west St. John three new steamship berths are to be completed before next winter, and the two contracting companies having the work in hand will have crews of men working day and night throughout the spring and summer on the timber substructure and the concrete face and surface. These wharves are to be equipped with steel warehouses, travelling cranes and all modern devices for handling traffic.

WESTERN CANADA

Tenders are about to be called for a post office building at Prince Rupert, B.C., estimated to cost $100,000.

At Winnipeg plans are in progress for a subway under the tracks on Portage Avenue. The estimated cost is $250,000.

The Mainer Electric Company, Limited, Winnipeg, have been granted permission to increase their capital from $100,000 to $500,000.

The date of submitting the bylaw to raise $250,000 for the extension of the Calgary waterworks has been postponed until April 30.

Tenders are to be called next month for a two-storey court-house, of stone and brick construction, at Swift Current, Sask. The estimated cost is $125,000.

Eight of the various building trade associations of Edmonton are now affiliated with the local Builders' Exchange, the last to come in being the sheet metal contractors.

Operations on the Saskatchewan Iron & Bridge Company's new factory at Medicine Hat are to be started again about May 1. The firm's headquarters are at Moose Jaw and the expenditure of $100,000.

At Calgary, Alta., on May 7 the ratepayers will be asked to vote on a bylaw to raise $300,000 for an electric light system. The superintendent of the city light and power department is Mr. R. A. Brown.

At Winnipeg, a syndicate has been formed to erect a new athletic club building at a cost of $750,000. A site has been selected and Messrs. Pratt & Ross, Electric Railway Chambers, Winnipeg, have been appointed architects.

Medicine Hat, Alta., is to have a flour mill estimated to cost $750,000. The prospective owners are the Maple Leaf Milling Company, Board of Trade Building, Toronto. It is expected that operations will be commenced about May 1.

Work is in progress in the new Arts building at Edmonton for the University of Alberta. The architect is Professor Burgess of the University and the general contractors are Messrs. Geo. A. Fuller & Company, Limited. The estimated cost is $500,000.

The new plant erected for the Mainland Ice & Cold Storage Company at Vancouver has been placed in operation The building is five storeys high, 88 ft. by 100 ft., and of fireproof construction, the block being lined with two layers of cork and the coils of refrigerator pipe and cold air ducts.

The public works department of the Provincial Government is co-operating with the various municipalities in Alberta for the purpose of constructing main trunk roads between the principal market centres. Half a million dollars.

which has been set aside out of the current revenue for road construction this year by the public works department, will be expended largely in improving the most used traffic roads, and with a view to completing in the next few years a system of main trunk highways.

It is stated that there is a likelihood of operations being renewed on the Empire Theatre at Edmonton, the excavation for which was taken out two years ago. The estimated cost of the building is $200,000 and the prospective owners are the Empire Theatre Company, of Edmonton.

In a lecture before the Royal Colonial Institute, London, Eng., upon the effect of the Panama Canal on Western Canada, Dr. F. B. Brooman, of Vancouver, said that the canal was already throwing a new economical and continental divide across Canada, two-thirds of whose future products were destined to be shipped by the Pacific.

Work is expected to be completed on the two remaining piers of the new 25th Street bridge at Saskatoon by June 1. The piers will be put in from scows, after which the construction of the reinforced concrete arches upon the piers already put in will be undertaken. The contract is being carried out by Messrs. R. J. Leckey & Company.

The Government of Saskatchewan has approved of plans for the building of a retaining wall on the north side of the Saskatchewan River. The Commissioners have apopinted a committee to take up the matter with the city engineer and report to the city council. The cost has been estimated roughly at $125,000, of which the Government would probably vote $100,000.

Six bids were received by Victoria city council for the fabrication and laying of the steel rivetted pressure pipe line for the Sooke Lake waterworks system. The specifications call for 10½ miles of 35-in. steel pipe, half of the plates to be 5-16-in. in thickness and half ⅜-in. The city has decided to do the trenching and back-filling by day labor. The tenders will be finally dealt with and the contract awarded at an early date.

Tenders will be called shortly for the erection of an office building for the Saskatchewan Co-operative Elevator Company, Limited, at Regina. Messrs. Store & Van Egmond are preparing detailed plans, and construction will be commenced during the summer. The type of construction will be reinforced concrete, sufficiently strong to carry two additional storeys if necessary at a later date. The exterior of the building will be a combination of pressed brick and terra cotta.

Building in Calgary shows satisfactory evidence of activity, judging by the returns for the first three months of the present year, which total about $600,000. According to the building department the outlook for the year is exceptionally hopeful, especially as the Dominion Government is preparing to expend large sums this year and next in the construction of a new post office building, terminal storage elevator and an armoury. It is also expected that permits for the new Canadian Northern and Grand Trunk Pacific depots at Calgary will be taken out this year.

The prediction that 1914 will be a year of much building construction in Winnipeg appears to be borne out by the permits issued so far this year. The record for the three months ending March 31 is $714,650 greater than the total value of the permits issued for the same period last year, and is only $175,760 lower than the record set in 1912. The total for the three months of this year shows 493 permits issued for 570 buildings, aggregating in value $2,839,550. In the permits issued to date there are practically no large office structures, of which quite a number of any size are for apartment blocks, and the heavy work has not yet been commenced. A five-storey addition is to be made to the Manitoba Cold Storage Plant at a cost of $60,000.

The Directors of the Burrard Inlet Tunnel & Bridge Company have received bids for the construction of the proposed bridge across the Second Narrows, B.C. The bridge, including the approaches, will be nearly one-half mile in length. It will consist of one wide swing span, 581 ft. 6 in. long, two fixed spans, 232 ft. long and two viaduct approaches. The structure will be entirely of steel and the roadway will be paved with wood blocks and will rest upon six piers. The draw will revolve on a platform supported by four wrought steel cylinders braced together and filled with concrete. The bridge itself will be of the Warren Brothers type. Separate accommodation will be provided for steam, street car, vehicular and pedestrian traffic. A clear headway of 45 ft. above high-water level will be provided and a clear waterway of 225 ft. will be available when the draw span is opened. A swing span will be operated by electric motors. Electrically-operated gates will safeguard the draws on either side and an elaborate system of signals and telephone connections will be used to direct traffic, both on the bridge and in the channel. The bridge was designed by the British firm of Sir John Wolf Barry, Lyster & Partners, Messrs. Cleveland & Cameron, of Vancouver, being the local associates, who carried out the preliminary work including test borings. Fifty large scale drawings were used to describe the specifications.

Interesting Addresses by Canadian Engineers

"Civic Road Building on an Economic Basis" was the subject of a report made to the town council of Amherst, N.S., by Mr. J. E. Lusby, who attended the recent Good Roads congress at Chicago. He stated that extensive experiments had been made by experts who had studied each phase of road construction, endorsing concrete as the coming pavement. The new design was a width of 16 ft. to 18 ft. such as would permit two motor busses to pass at a speed of twenty to twenty-five miles an hour. Instead of the high crowned centre which prevented cracking and tended to drain off water in bitulithic, an almost flat surface was agreed upon, but the centre had an exact thickness and was two inches higher than the sides.

Addressing the Institute of Civil Engineers at London, Eng., on April 8, on "The Transportation Problem in Canada and Montreal Harbor," Mr. F. W. Cowie, who is one of the Commission at present making tour of inspection of European and British ports, referred to the fact that with the possible exception of the development of Glasgow Harbor there was no more romantic episode in the annals of harbor engineering than the making of Montreal an ocean port. Mr. Cowie described at length the design, capacity and cost of Canadian grain elevators, making interesting comparisons with the methods of handling grain in other countries.

In a lecture on "The Engineer and the Public" delivered before the Ottawa Branch of the Canadian Society of Civil Engineers, recently, Mr. W. J. Francis, consulting engineer of Montreal, commenting on the different definitions of an engineer stated it had been estimated there were 110 varieties. The action of corporations and individuals in frequently inviting competition between engineers and which occasionally resulted in other than Canadian engineers being given important work, was condemned by Mr. Francis who asserted that engineers had a right to expect that they would be given the preference in their own country. Advice from engineers of other countries might be obtained if necessary, but the native engineer should be allowed to carry out the work.

Personal Mention

Mr. C. B. Carter has resigned his position as Municipal Engineer of West Vancouver, after a service of two years.

Mr. A. J. Donegan has received an appointment as superintendent of the Algoma Eastern Railway, with headquarters at Sudbury, Ont.

Mr. John C. McGregor, a well-known Toronto builder and contractor, died on April 12 in his 81st year. Mr. McGregor was a native of Moffat, Scotland.

Mr. L. C. Fritch, chief engineer of the Chicago Great Western Railroad, has been appointed assistant to the president of the Canadian Northern Railway, with headquarters in Toronto.

Mr. Henry Sheard, a Toronto architect who retired from business about twenty-five years ago, died on April 8 after a short illness. He was born in Toronto in 1853 and lived practically all his life in the city.

Mr. Wm. Pearse, who is an applicant for the vacant office of City Architect of Toronto, is a native of the Queen city. After passing the final examination of the Ontario Association of Architects, he went to New York, took a five-year course in civil engineering at Cooper Union where he graduated in science, and later in civil engineering. Subsequently in Germany he took a three-year course in engineering and twelve years ago passed the three-day naval examination as a first-class structural draughtsman. Mr. Pearse is first vice-president of the Ridley Steel Construction Company, Long Island City, New York, and is an expert specialist and consulting engineer.

Canadian Railroad Development

According to a statement made recently by Mr. McNicholl, first vice-president of the Canadian Pacific Railway, the Lake Shore line near Toronto will be complete and ready for passenger traffic about July 1. Work on the construction of the new Union Station will probably be commenced in May.

The last rivet was welded a few days ago in the new C. P. R. bridge at Donlands on the line of Woodbine Avenue, nine miles from Toronto Union Station. The new bridge, which is of steel construction, is nearly 1,000 ft. long and weighs over 1,200 tons. It is supported on nine steel towers and two concrete abutments. It gives the C. P. R. a double track from Streetsville to Agincourt. The Walkerville Bridge Company are the builders, the contractors for the cement work being Messrs. Dickinson & Burns. The double tracking of the line from Agincourt to Leaside will be done by Messrs. Stein & Read.

In an address on "City Planning" at the City Development Exhibition in Toronto a few days ago, Mr. J. P. Hynes suggested the construction of a steam railway service for suburban Toronto, running east and west from the Yonge street crossing to a point twenty-five miles distant on each side from the heart of the city. For this purpose a Grand Central station would be built at Yonge street and a number of stations at various distances along the line. Eventually the road could be linked up with the proposed railway to be operated by the Harbor Commission, and in this way would belt the city.

Mr. Morley Donaldson, vice-president and general manager of the Grand Trunk Pacific witnessed the linking up of steel east and west on April 8 by the laying of the last mile of track. There was no elaborate ceremony, only officers of the railway being present. The formal ceremony, to include the driving of the golden spike, will take place later. The point where the steel joins is Nechako River, B.C., 371 miles east of Prince Rupert and 1,375 miles from Winnipeg. Since the beginning of the year steel has been laid on 143 miles of line. The construction of the line was commenced at Manitoba Sand Hill in October, 1905, while work from the Pacific was commenced in May, 1908. The laying of steel was started in September, 1906, at Portage La Prairie.

Publications Received

The Asbestos Manufacturing Company, Limited, 263 St. James Street, Montreal, have issued an attractive booklet, entitled, "The Town of Asbestoslate." This booklet illustrates some charming homes and attractive buildings roofed with Asbestoslate. It contains many valuable pointers for prospective builders.

"Waterproofing for Cement Houses," is a booklet in which the problem of waterproofing cement stucco houses is discussed logically and interestingly. Such a careful treatment of this subject is bound to increase interest in the use of cement stucco and in the necessity of safeguarding against dampness. The booklet is issued by the Ceresit Waterproofing Company, Chicago.

"Flat Slate Roofing" is the title of a book received from the North Bangor Slate Company, the purpose of which is to show that flat slate roofs have stood the test of time and earned a record for durability, economy and general satisfaction. The book contains the published testimony of architects and others as well as illustrations of various types of flat-slate-roofed buildings. The Bangor Slate Association, Bangor, Pa., offer to deal with all enquiries, sending full information and suggestions for specifications.

Trade Notes

The Industrial Engineering & Machinery Company, Limited, Montreal, Sales Agents for the Traylor Engineering & Manufacturing Company of Allentown, Pa., have just secured from the Asbestos Corporation of Canada, for their Thetford Mines Mills, an order for a 60-in. "Blake" type Jaw Crusher. This will be the largest crusher in the Thetford district.

We are informed that excellent results have been obtained in Keystone copper bearing steel sheets since they were placed on the market last year by Messrs. B. & S. H. Thompson & Company, Limited, Montreal. These sheets have demonstrated much greater durability than ordinary steel sheets and are, therefore, particularly adaptable for use in the manufacture of all exposed sheet metal work. Messrs. Thompson are prepared to supply a descriptive booklet and samples to all interested.

Messrs. M. Beatty & Sons, Limited, recently launched the dipper dredge which they are building for the C. S. Boone Dredging & Construction Company, of Toronto. This dredge is of steel and is 100 ft. long, 40 ft. wide, 10 ft. deep at bow and 8 ft. at stern. It is of the Crane type, the crane being 40 ft. long. The dipper is of 5 cubic yards capacity. The dipper handle is 61 ft. long, which will allow it to make 40 ft. of water. The main engine is double cylinder, 15 in. bore by 15 in. stroke, the boiler being 10 ft. diameter by 12 ft. long, of the Scotch Marine Type. Each bow anchor or spud is operated by an Independent Reversible Engine 10 in. bore by 10 in. stroke, compound geared, the anchors being raised and pinned up by steel cable. The engine for handling the stern anchor is 9 x 9 compound geared. Located on each side of the deck forward, is a 7 x 7 double cylinder triple friction drum engine, which is used for warping the dump scows into position. Messrs. Beatty expect to have the dredge completed and ready for towing by the first of May.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Randolph 6018 - 1155 Peoples Gas Bldg.
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **April 29, 1914** **No. 17**

Principal Contents

The Perfect Specification ... 507
The Manager Plan of Municipal Government ... 508
By Kenyon Riddle
Cracking in Concrete Roads ... 509
Recent Developments in Concrete Highway Construction ... 510-12
By L. S. Bruner
Light Floors for Highway Bridges ... 512
Progress Records on Sewer Work ... 513
The Modern Type of Cement Gun and Its Work. Part 1. ... 514-20
By Carl Weber
A Warehouse with Girderless Concrete Floors ... 520
The Control or Prevention of Stream Pollution... 521-3
Paul Hansen
Typhoid and Paratyphoid along the Richelieu River.. 523
Constructional Features of the Herald Building at Calgary ... 524
Methods and Costs of Encasing Steel Structures in Concrete to Prevent Corrosion ... 526-7
The New Courthouse at Vernon, B.C., and Other Structures ... 527-8
The New Provincial Law Courts at Winnipeg ... 529
By R. L. Riggs
New Building for National Trust Company, Montreal. 530
Three Types of Fireproof Building Construction ... 531
By Thos. M. Goodrich
Prize Design for Hydraulic Power Station ... 532
Novel Type of Foundations ... 533
Letter to the Editor ... 533
(J. W. Ledoux)
Technical and Economical Aspects of Road Building in Quebec (Conclusion) ... 534-6
By Gabriel Henry
Constructional News ... 536-8

The Perfect Specification

THAT there is a lawsuit in every building contract (at the pleasure of the parties concerned) is an accepted axiom; hence, the contract is a document that is usually drawn up with considerable care and legal minds are not infrequently requisitioned in its preparation. When it comes to the specification, however, laxity is more honoured in the observance than in the breach. The classes are strung together one below the other, with but little regard to what has gone before or what is to follow. Repetition and tautology become wearisome, while an infinity of unnecessary detail prolongs the length of the document beyond the bounds of necessity. The fact is only too often overlooked that the specification is as much a legal document as the contract; indeed it forms, with the plans—and for the matter of that with the correspondence that ensues—a part of the contract, and the two must stand or fall together. Specification writing must be regarded as an important branch of the work of the engineer and the architect, and it is difficult to understand how the lamely-worded, halting, ungrammatical documents that one only too often sees can come from the pens of men whose calling presupposes the receipt of a fairly advanced education.

Clearness, brevity and consistency are the three things to aim at in writing a specification. Lengthy sentences of necessity become involved, and the snappiness of modern journalism may be followed with advantage. Reiteration of descriptions of similar work and materials does not, as is commonly thought, add strength to the document; and, too, there is ever the danger of dissimilar clauses on similar matters creeping in, to the confusion of all parties concerned. Tautology is to be avoided if possible, but true literary excellence is not to be attained and an expressive word or phrase had better be used over and over again if to ring the changes on it would mean any danger of confusion of ideas. A general clause to the effect that everything shall be done in the best and most workmanlike manner will save an infinity of that needless description of working processes which, to use the words of an authority on the subject, is often carried "to the verge of absurdity." Words such as "proper" and "sufficient" have practically no meaning at all, and the writer should avoid them by stating clearly and concisely what is proper and sufficient. Small detail sketches may be introduced in the margin with advantage, not necessarily as saving description but as helping to elucidate it; but even these may be overdone and "carried to the verge of absurdity" unless the writer places due restraint upon himself. "The description in specifications of workmanship and material of the highest class in positions which any practical builder knows to be unreasonable and unlikely to be insisted on," says the authority already quoted, "leads to a general system of discounting the written requirements by the experienced estimator, who tenders accordingly, and at a much lower rate than his deluded competitors, who weakly suppose that the specification means what it says." To sum the matter up: If the specification drafter clearly understands what he is writing about, says exactly what he means and not a word more, clearness, brevity and consistency will have been attained.

Many books have been published giving complete specifications or specimen specification clauses for both building and engineering works. Used with judgment such books may prove of the greatest service; but

1914 23(17)

there is ever the danger of irresponsible consultation and the extraction of clauses which may, when strung together and read as a single document, have all the bad features that have been referred to above. Stock clauses to fit the requirements of every class of work cannot be drafted, and the architect or engineer who dabbles in such things may court serious trouble with his clients. Every clause must have precision of application, for incertitude is fatal. The wide tendering of which so much is heard is due largely to the atmosphere of uncertainty which attaches to many specifications. Two men may read a badly framed clause in two different ways, three men in three different ways, and so on; whereas a properly drafted clause should be of so definite a nature that it could convey but the one meaning, and that the meaning that it was intended by its writer to convey. Specification writing might, in fact, be reduced almost to an exact science, free from ambiguities and uncertainties, and offering no scope for the exercise of the "speculative" mind. Given a brief, clear and consistent specification, and a full set of quantities (with, of course the necessary drawings) and the tenders of a score of competent men need not vary to a greater extent than five or six per cent. As things are, fifty or sixty per cent. is not uncommon.

The Manager Plan of Municipal Government*

By Kenyon Riddle †

THE advantages of the manager plan of municipal government are being discussed in so many cities just now that the following notes on the subject from one who has had the benefit of some experience as engineer-manager of a small city may be of interest.

Since most of the affairs of the smaller cities, at least, are of an engineering nature, the city manager should be generally posted in engineering. Since he may act as an agent or arbitrator between the governing body and the people, he should be tactful. As a judge or adviser of a great deal of the city's business —such as purchasing material, allowing estimates, recommending improvements and expenditures, submitting ordinances and suggestions in general for the approval of the administrators—he should be familiar with cost data, a good judge of benefits derived from different acts, an economist, honest, impartial and free from politics, and in general be purely a business man and expert servant of the commission.

As to working principles, these can best be illustrated as follows. Imagine three (or five) horizontal lines converging to one central point, these lines representing the governing body; and diverging from this point the number of lines necessary to represent the different departments. The focusing of all the lines into one point shows clearly centralization of responsibility.

In order for any act to be executed, it must first be passed up by the legislative body as a whole, then condensed and made to pass through one point—the controlled executive—to the proper department heads. Now suppose the act was not carried out in a manner suitable to the people. They protest to the commissioners, whereupon, in order to save criticism, they go directly to this single head, and in order to hold his job he gets busy. And finally, when the blame is located, it may be found in some subordinate official of some department; however, the act is easily traced and finally filtered through the group.

The principal objection to this new plan is the fear of one-man power. The new plan eliminates one-man power. With the commissioners acting as a group, through one controlled executive, all of the fancies, hobbies or any peculiar ambition that one man might have are neutralized by the combined judgment of the other members of the commission. Also, if any one of the board is interested pecuniarily, the passing of every act by the group destroys all opportunities for such deals.

The manager is servant and executor, not boss.

Under the council form of government, there was confusion most of the time, due to jealousy among the councilmen, politics, special interests, lack of expert advice. Further confusion arose because the affairs of the city were divided and subdivided among the several committees and members and also because of complexity in general.

These same things may exist in a commission, but there is much less chance. Jealousy may exist, due to the fact that special charge of the different departments, etc., is divided among the commissioners. There is less danger from politics because the body is smaller in number and each man is more conspicuous. Special interests may be more detrimental under commission form because of each member having special charge over his departments. Lack of expert advice may be less dangerous because at no time does all of the board go out at once and the older members are apt finally to become posted on certain expert knowledge—at the city's expense. And finally, one of the greatest features in favor of commission form over the aldermanic or council form is the fact that an entire new body does not come in and spend the first few months of their administration tearing down what their predecessors have started. Also, since the majority of the cities do not lay much stress on records, it is possible for the remaining commissioners to put the new man wise to their past proceedings.

I maintain that it is possible for all of these objections to be eliminated, partially or wholly, by the engineer-manager plan. As a first step toward this end, a change should be introduced in the present laws of the various states, authorizing the commission plan, so that every act of importance shall be acted upon by the commission as a whole. For, with the two main ideas involved in the commission form—that is, the Lynn form (as in Lynn, Mass., and as has been adopted in Kansas) and the general plan (as in Galveston and Des Moines)—there is one great weakness, viz.: In the former electing its members to specific posts and, in the latter, appointing its members to perform special duties after they are elected. Both methods are accompanied by such objections as individual control, or as many different governments as there are commissioners, and in general lack of unity. Furthermore, no matter whether the commissioner is elected to his duties or whether these are assigned, it is hardly possible to get a true representative of the people (as the commissioner should be) when technical fitness has to be considered. Therefore, in order to avoid every objection which can be imagined from a lack of unity and individual action, elect the commissioners at large, make them responsible as a body, and make it necessary for every important act to be passed upon by the entire body, thereby balancing or equalizing the freak ideas that any of the members may possess.

---

* Engineering News.

†Engineer-Manager, Abilene, Kan.

The next and, as already suggested, an equally important step, is to provide a manager (and for most places an engineer-manager) to serve the commission as an expert. In no case would it be policy for the state to define his duties. It is quite likely that the different towns or cities wishing to adopt the manager plan would have distinctly different views as to the duties of a manager. Some might make the qualifications strict as to his ability to regulate social matters, others might wish a manager of distinctive financial ability—but still the principal requirement should be experience and fitness in matters of an engineering nature.

It is quite evident that the duties of the city manager should be fixed by city ordinance. As a model for such an ordinance, suitable for the majority of places, the following is suggested:

An Ordinance

Creating the Office of City Manager, Defining his Duties and Salary. BE IT ORDAINED By the Mayor and Commissioners of the City of   :

City Manager: There shall be appointed by the Mayor and Commissioners a City Manager who shall be the administrative head of the municipal government subject to the supervision and control of the Commissioners and he shall be responsible for the efficient administration of all departments. He shall be appointed without regard to his political beliefs and may or may not be a resident of the City of   when appointed. During the absence or disability of the City Manager the City Commission may designate some properly qualified person to execute the functions of the office.

Powers and Duties of the City Manager: The powers and duties of the City Manager shall be:

(a) To see that the laws and ordinances are enforced;

(b) To attend all meetings of the Commission, with the right to take part in the discussion but having no vote;

(c) To recommend to the Commission for adoption such measures as he may deem necessary or expedient;

(d) To give all lines and grades for city improvements which require the same;

(e) To have control, management and direction of all improvement work of any nature which pertains to and comes under engineering principles. The above duties shall include the making of estimates, supervision during construction, inspection and the maintenance thereafter; he shall have control and management of all streets and alleys. He shall have charge of and control the entire water and sewer system and keep a complete underground record of the same.

(f) To be inspector of all wiring, sewer connections, plumbing, water connections and chimney construction. He shall approve all estimates of the cost of public works, and recommend to the City Commissioners the acceptance or rejection of the work done or improvements made.

(g) To recommend to the Commission the appointment or removal of all heads of departments and all subordinate officers and employees of the City which come under and pertain to principles of engineering; all appointments to be upon merit and fitness alone.

(h) To exercise control over all departments and divisions created by the Commission.

(j) To keep the Commission fully advised as to the financial condition and needs of the City.

All the powers enumerated, however, shall be subject to the supervision and control of the City Commission.

Salary: The City Manager shall receive such salary as may be fixed by ordinance of the Commission.

All ordinances heretofore made so far as inconsistent and in conflict with this ordinance are hereby repealed.

Cracking in Concrete Roads

PROBABLY more criticism of concrete pavements is centered on the cracks which occur and expansion joints than upon any other features of this kind of construction. A. N. Johnson, state highway engineer of Illinois, in a paper before the American Road Congress attributed the formation of cracks to unequal settlements of the subgrade, supplemented by external stress due to the passage of heavy traffic or to the movement of the slab under temperature changes. In commenting upon this, Henry S. Spackman refers to experiments conducted by him which showed that when concrete is mixed as wet as it generally is in modern road work it shrinks during the first twenty-four hours and then expands during the next three or four months, the shrinkage being undoubtedly due to a draining out of the water and the expansion to the continuation of the chemical action, which continues for months and even for years in a continually lessening degree. In view of this shrinking which begins almost as soon as the concrete is laid, it seemed impossible to prevent the cracking of the pavements unless the exudation could be prevented. Mr. Spackman has experimented with the addition of hydrated lime for this purpose, and compared 18 test pieces to which hydrated lime had been added to the extent of 10 per cent. of the amount of cement in some instances and 20 per cent. in others, and 9 test pieces containing no lime. During the first twenty-four hours the average contraction for those containing hydrated lime was .007 per cent., as against .015 per cent. for the pieces containing no hydrated lime. At his suggestion also the Office of Public Roads laid a short stretch of road at Chevy Chase, Washington, D.C., using hydrated lime, and another was laid near Salisbury, Md. These experiments all lead him to believe that the addition of 10 to 15 per cent. of hydrated lime will be found beneficial not only in reducing cracks, but also in eliminating the formation of holes and soft spots. Such addition, he says, not only causes the mortar to hold the water, but the more plastic and viscous mortar eliminates the segregation of the cement from the sand and secures a more homogeneous mixture, lessening the liability of pockets of material deficient in cement.

Plowing up worn brick pavement, instead of employing a large gang with picks and crowbars, was the experiment successfully tried by a contractor in Louisville, Ky. The brick in the 1-mile stretch to be repaved was worn too thin to be of use in building construction, and its use as pavement foundation was prohibited. The contractor used a rooter plow, with a heavy point in place of the regular blade, propelled by a 10-ton steam roller—an unusual procedure explained on the ground that the contractor owned no traction engine except the roller, which was idle at the time. This combination tore up half a block of street in from two to three hours, with a force of four or five men.

Recent Developments in Concrete Highway Construction*

By L. S. Bruner, Montreal

It is a generally accepted fact that any type of highway, which is considered permanent, must have a concrete base. Within the last decade, many communities have tried concrete, not only as a base but as a wearing surface as well. It is needless to say, however, that there were some cases which were not entirely satisfactory, but the successful results so far outnumbered the failures that this form of construction is now being adopted in all parts of the United States and Canada.

The early form of construction followed very closely the method then in vogue for the laying of concrete sidewalks. This is exemplified in the pavement laid by the city of Bellefontaine, Ohio, in 1893, and is probably the first of its kind in North America. The pavement consists of a machine mixed 1:4 gravel concrete base, four inches thick, and a wearing surface of a 1:1 mixture of Portland cement and clean coarse sand, two inches thick. It was laid in five foot strips starting at the curb, each strip being cut into blocks five feet square. In other words, the pavement has joints running parallel and perpendicular to the curb every five feet. The surface was finished smooth after the manner of sidewalks and then marked with V-shaped grooves about one-quarter of an inch deep every four inches transversely and longitudinally.

After twenty years service these pavements are in remarkably good condition, considering the meagre information at hand when they were built. The only failure has been along the longitudinal joints, which, in the light of later experience, have been found entirely unnecessary.

The next place where concrete for paving streets was used was Richmond, Ind. In a paper read at the 1910 convention of the N.A.C.Y., Mr. F. R. Charles, the City Engineer, says, "The City of Richmond, Ind., cannot claim to have a large amount of concrete roadways, but here some of the earliest street pavements of this construction were laid. The first roadway was built in 1896 and now has nearly 14 years of life and usefulness to its credit, and is still continuing its service without having cost one cent for repairs." This pavement consisted of a five-inch base of 1-2-5 concrete and a wearing surface of 1-2 mortar one inch thick. No more pavements were laid in Richmond until 1901, but since then a small amount has been added each year, and at the end of 1911 there was a total of 18,238 square yards.

Concrete Construction

Probably the most widely known concrete highways are those of Wayne County, Mich. This is no doubt due to their satisfactory results, modern methods of construction and comparatively large mileage, for out of a total of 116.221 miles, including tar and water bound macadams, gravel, brick, bitulithic, creosote block, rock, asphalt and concrete, 65.745 miles (or over half) are of concrete, of which about 35 miles were laid during the past year. In 1913 twenty-five more roads were built.

The first concrete road built in Wayne County in 1909 was on Woodward Avenue. It was approximately one mile long, with 18 feet of concrete and 3½ feet shoulders. Woodward Avenue is the main business and residential street of Detroit and extends northward through a prosperous farming community. It is subjected to a heavy and continuous automobile and farm waggon traffic. The method of construction used was a two-course pavement, of which the base was 4 in. thick, of 1:2½:5 limestone concrete with a wearing surface of 1:2:3 mixture, 2½ inches thick, of which the aggregate was sand and crushed field stone. Joints were placed every 21 feet and filled with various fillers including Georgian pine boards and certain bituminous compounds. Since the first road was built the methods have undergone several changes until at present it is the custom to use a 1:1½:3 gravel concrete mixed wet enough to pour. Joints are protected from chipping by steel plates, and expansion and contraction is provided for by filling between the plates with tarred felt. These joints are placed perpendicular to the axis of the road at intervals of 25 feet.

Before placing the concrete the subgrade is thoroughly rolled and 7-inch planks are laid 16 feet apart as side forms. Before receiving the concrete the subgrade is moistened and the concrete delivered from a batch mixer and deposited at the proper place by a bucket running along a swinging boom. The surface is shaped by means of a template cut to the crown of the road, 2 inches in 16 feet; after this two men operate a box tamper, and following them are two finishers. These implements, as well as a bridge upon which the finishers work, rest on the side forms which act as tracks. The finish is obtained with wooden floats. After the concrete is once shaped no one is allowed on it until it has fully hardened. It is then covered with tarpaulins, and when about twenty-four hours old these are removed and the surface sprinkled and covered with a layer of about two inches of dirt, which is kept moist for at least a week. In this way the concrete is not allowed to dry out quickly, thus preventing cracks due to shrinkage during setting.

As above stated, transverse joints are placed every 25 feet. They consist of two steel plates 3 inches deep, between which are two layers of tarred felt of a depth equal to the thickness of the concrete. These joints have the same crown as the road, and the whole is assembled by the side of the road and then staked in place with iron pins, which are removed after the concrete has been laid.

The concrete is allowed to harden for a couple of weeks before the road is opened for traffic, and after it is at least three weeks old, shoulders are rolled 4 feet wide on either side. Drainage is provided for by ditches or drain tile, or a combination of both.

That these roads are satisfactory is proved in several ways. First, the people, especially the farmers, are anxious to have more of them. Second, the sixth Annual Report of the Board of County Road Commissioners of Wayne County states, "Wayne County has received some very flattering commendations on her

---

*Read at a meeting of the Canadian Society of Civil Engineers, Montreal, April 9, 1914.

Levelling process on concrete road work at Winnipeg.

Construction of Grand River road, Wayne County, Mich.

concrete roads during the past year, and we have been visited by and received request for information from upwards of 1,000 Highway Engineers, Road Commissioners, Mayors and others interested in good roads and streets. All over the country communities are putting down concrete roads, streets and alleys, using practically our specifications and methods." Third, Mr. E. N. Hines, who has been a member of the Board for several years and who is one of the main sponsors for these roads, was re-elected last November by an overwhelming majority.

The cost of the roads has varied from $1.04 to $1.70 per sq. yd. or at a rate of from $9,762.14 to $15,956.34 per mile of road, which includes everything connected with the construction of the road, but is based on yardage of concrete only.

In this vicinity there is an example of this type of construction. In 1912 the Quebec Highway Department authorized that portion of the King Edward VII. Highway passing through Napierville, Que., be built of concrete. The specifications of Wayne County were followed as nearly as possible, the main variation being the joints. These were made narrower and the steel plates were eliminated. The joints were made by folding a piece of 3-ply tarred felt around a steel plate. The whole was staked in position and the concrete deposited up to and three feet beyond the joint. The plate was then withdrawn and the concrete tamped back against the paper, thus closing up the space left by the plate and making a joint very little wider than ⅛-inch.

Our methods of construction have been used, including two course pavements of reinforced concrete and several patented forms, viz., Hassam, Blome and Dolorway.

The Hassam pavement consists of several courses of different sized stones which are deposited, grouted and rolled. Each succeeding course is placed on the preceding one before it has set and the surface finish made with screenings which are also grouted and rolled. The construction is very similar to a water-bound macadam which has a cement grout rolled in. This method of construction has since been changed. Now only one course is laid of uniform size stone about 2 in.—with no screenings. This leaves plenty of space between stones so that the grout is able to penetrate the whole pavement without obstruction.

The Blome pavement is made in two courses, the base being about 5 inches of 1:2½:5 concrete and the top of 1:2 mixture of cement and granite, not thicker than ½-inch. This wearing surface is composed of fixed proportions of various sized aggregates and is marked into blocks about 4 x 9 in. by grooves running longitudinally and transversely. An example of this kind, with which many are no doubt familiar, is the pavement laid by the Montreal Tramways Company on St. Catherine Street West.

The Dolorway pavement consists of a concrete base with a wearing surface of bitumen and sand. The bitumen is spread on in a hot state to a thickness of ¼ to ⅜ of an inch, and upon this is sprinkled sand, giving the street the appearance of sheet asphalt.

In order to obtain the most satisfactory results with this type of construction, the following details should be given careful attention. The sub-grade should be well drained and compacted and be in a

Template tamper in use on the Grand River road.

Assembling joint with steel protection plates.

damp condition when the concrete is deposited. The aggregate should be clean and well graded. The mixing should be uniform in order to give the pavement uniform strength. The concrete should be mixed rich enough to resist abrasion—not leaner than 1-2-4. The surface should be given a wood float or broomed finish to prevent slipperiness, should not be allowed to dry too quickly while hardening, and either a very narrow joint should be made or the edges of joints protected from chipping by some form of steel plate.

The advantages claimed for concrete roads are as follows:—They are low in first cost, averaging about 10 per cent. more than macadam and less than other forms of permanent pavement. They are easily and cheaply maintained. They are, in themselves, dustless as there is do detritus from their wear, making them easily cleaned and sanitary. The hard even surface affords the lowest resistance to traffic and the rough finish gives a good foothold for horses and prevents skidding of automobiles.

Light Floors for Highway Bridges

Wood Block, Bituminous Wearing Surface and Plank to Meet Various Conditions of Traffic

THE Illinois State Highway Commission, in its annual report, gives some suggestions concerning floors for steel highway bridges which would seem to answer a problem of more or less general occurrence if we may judge by inquiries received. The discussion, somewhat abridged, is as follows:

The largest item of expense in connection with the upkeep of steel bridges not having concrete or other permanent floors, is that of floor maintenance. Until a few years ago, the floor almost universally specified for country highway bridges consisted of white or burr oak plank, from 2½ to 3 inches in thickness. When first-class material could be obtained at a cost of $25 per thousand feet board measure, such floors proved to be fairly economical if not subjected to heavy traffic. But now it is almost impossible to obtain at any price a good quality of white or burr oak bridge plank.

The lightest concrete floor that can be designed to carry modern traffic with safety weighs 40 pounds or more per square foot, and in order to protect such a floor from excessive wear and to distribute concentrated loads sufficiently so that they will not produce local failure, a wearing surface of gravel, macadam or brick weighing a minimum of 50 pounds per square foot is necessary.

Steel bridges carrying plank floors are rarely, if ever, designed to carry more than the dead weight of the bridge itself, which includes about 12 pounds per square foot for the floor, and a live load of 100 pounds per square foot, provided by law.

To place a concrete floor on a steel bridge, designed to carry a plank floor, would impose, therefore, an additional dead load on the structure amounting to the difference between 90 pounds per square foot, the weight of the concrete floor and wearing surface, and 12 pounds per square foot, the weight of a plank floor, or about 78 pounds per square foot.

The proposed floor must weigh but little more than the floor for which the structure was designed; it must not be unduly expensive, and it must be as durable as possible.

The material which best meets these requirements seems to be timber treated with creosote oil to prevent decay. All woods treated with creosote oil seem to resist decay equally well. Any wood may therefore be used which is susceptible to the creosote treatment and which will resist the wear coming upon it.

For existing wood floor steel bridges, located in or near cities, which carry a considerable amount of traffic, it is recommended that a creosote wood block pavement be laid on creosoted pine sub-plank. Such a floor weighs about 30 pounds per square foot. This is about 18 pounds per square foot in excess of the floor weight a majority of wood floor steel bridges are resigned to carry. However, as this type of floor is very much smoother and stiffer than the ordinary plank floor, the reduction of vibration due to heavy moving loads is greatly decreased. This is a factor of safety which will balance somewhat the greater dead weight of the structure. However, a careful investigation of the strength of the bridge should be made before a floor of this character is laid.

At present prices for material this type of floor can be laid for about four times the cost of a 3-inch plank floor. If proper materials and workmanship are used, there is little question but that such a floor will last 12 years or more, possibly 25 or 30 years.

For existing bridges in good condition and of proper design, located on roads at some distance from a city, carrying a moderate amount of traffic, a floor consisting of 3-inch creosoted sub-plank on which is placed a wearing surface about three-quarters of an inch thick of fine gravel or stone chips flushed with heavy asphaltic filler will be found serviceable and economical. Such a floor, if properly constructed, will present a smooth, elastic surface which will reduce vibration. A floor of this character weighs but a few pounds per square foot more than a 3-inch oak plank floor and is far more durable. The wearing surface will probably require renewal at intervals of from 2 to 6 years, depending upon traffic conditions. As the wearing surface may readily be renewed by day labor, at a cost of about 50 cents per square yard, the item of maintenance is small compared with the cost of maintaining an untreated plank floor. There is no reason why a floor of this character should not last as long as a creosoted block floor, providing the sub-plank is kept protected from wear by a properly maintained wearing surface.

For existing country highway bridges, in good repair and of sufficient strength, where traffic is light and little wear comes upon the floor, creosoted oak plank with no special wearing surface can often be used. Red oak can be used to advantage for this purpose, as it is readily susceptible to treatment with creosote oil, wears less than a softer wood and will probably last as long as far as decay is concerned as any other creosoted timber.

In this connection it is worthy to note that the rate of wear on an ordinary plank floor greatly increases with the age of the plank, owing to the softening of the wood as decay advances. As the creosote treatment protects the plank from decay, a floor of this character will wear better than a floor of untreated material, as the wood remains hard and resistant until decay sets in.

In the light of the above discussion it is therefore well to hold in mind the following points:

1. Old steel bridges are rarely, if ever, strong enough to carry with safety a concrete floor.
2. For existing steel bridges in good condition and of satisfactory design, located in cities or elsewhere where traffic is heavy and ordinary plank floors rapidly wear out, it will be found economical to refloor with creosoted sub-plank and creosoted blocks.
3. For existing steel bridges in good repair and of satisfactory design, carrying moderate traffic, but yet where wear is of considerable importance, it will be found economical to use creosoted plank with a bituminous wearing surface.
4. For existing steel bridges in locations where an ordinary plank floor rots rather than wears out, a creosoted plank floor with no special wearing surface will be found economical.

If a proper selection of floor is made, and the material used is subjected to rigid specifications and inspection, this floor should in most cases outlast the steel bridge on which it is placed.

Progress Records on Sewer Works

THE engineer in charge of constructing the intercepting sewer and the sewage disposal plant in Schenectady, N.Y., is keeping a graphic record of the progress of construction which is useful not only to his office in showing at a glance just how the work is progressing, but also to enable a council committee or any interested citizens to appreciate this with a clearness which figures might not give.

The general method is shown on the accompanying illustration of the interceptor record. The work as plotted on the left hand side of the chart is divided into three parts—the underdrain, the concrete invert, and the sides and top of the sewer. The entire line of the sewer is first laid out by stations, running from zero up to 82 + 50, the space between the lines representing the structure being left open, as shown in the vicinity of station 33 in the illustration. A different color is chosen for each month, the five months of August to December being shown. At the end of each month the section or sections of the sewer completed during that month are filled in with this color. As may be seen, sub-drains are laid in certain sections only and are not continuous throughout the sewer. The diagram also shows that at the end of each month the invert had been carried somewhat ahead of the barrel of the sewer, as would naturally be the case. It appears that at the end of December the sewer had been completed, except that two openings, from about station 31 to 37, and from about station 44 plus 75 to station 55, had been left open because of certain difficulties which could be overcome better later on, as after emptying of the canal, for instance.

At the bottom of the diagram is shown the percentage of work completed at the end of each month, this showing that about 81½ per cent. had been completed on December 31.

At the right hand end of the sheet is another set of diagrams, these being vertical columns showing the amount of work done each month on the several items of the contract. Beginning at the left hand end these columns refer to sewer type A; sewer type B; manholes; cast iron pipe; tile underdrain; rock excavation; extra earth excavation; extra earth fill; extra broken stone fill; lumber in foundations; lumber in sheathing; extra concrete, and extra steel. In this case a different scale is used for each column, adapted to the units upon which the bid was based and the total amount of work which is to be recorded. Different colors are used to represent the work done during the different months.—Municipal Journal.

Lumber cut in British Columbia in 1913 totalled 1,348,000,000 ft. b.m., exclusive of piles, poles, posts, etc., according to a recent report of Mr. H. R. McMillan, provincial forester. He estimates that the Government revenue on the 1914 cut will be $3,000,000.

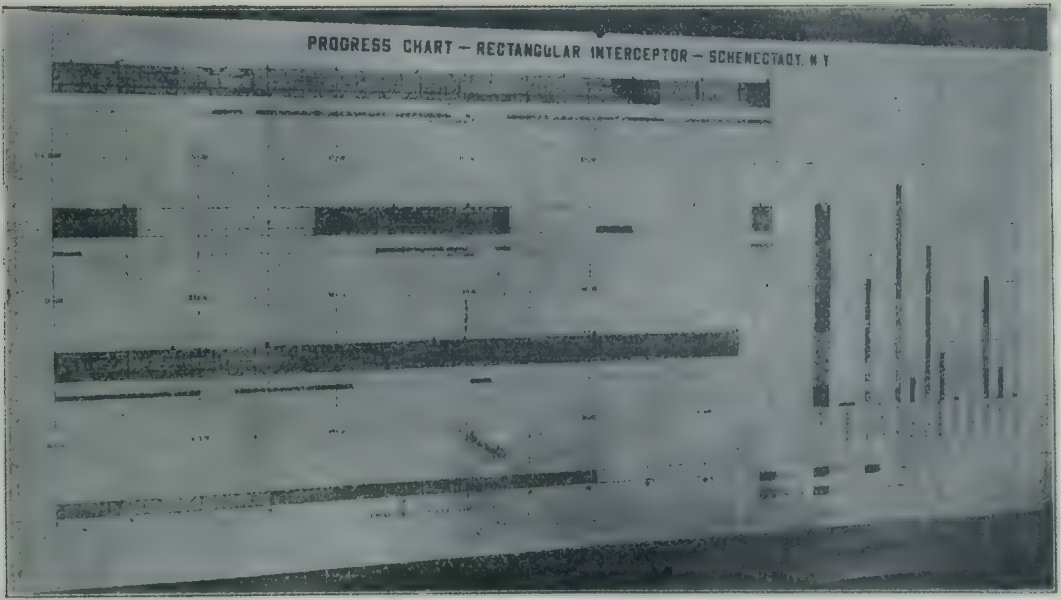


Chart for recording progress of each feature of construction work.

The Modern Type of Cement Gun and Its Work*—Part I.

By Carl Weber

THE Cement Gun is a machine invented about six years ago for the purpose of "shooting" a coating of cement mortar or the like onto construction surfaces, as, for instance, on concrete, brick, tile, wood and steel work. The gun is operated with compressed air. The mortar is deposited in a uniform coat with so great a force that it not only adheres to new and old surfaces with the utmost tenacity but it also expels by its impact all superfluous air and water, and in this manner becomes so dense that it is an excellent waterproofing medium. If used on interior or exterior wall surfaces the finished product resembles cement stucco and, as a matter of fact, the original purpose and the first work to which the cement gun was applied was the production of such work. It soon became apparent, however, that the product of the cement gun was superior to handwork and that the material displayed qualities which put it in a class by itself. Therefore in order to distinguish the cement gun product from all other classes of cement work, the name "Gunite" was adopted.

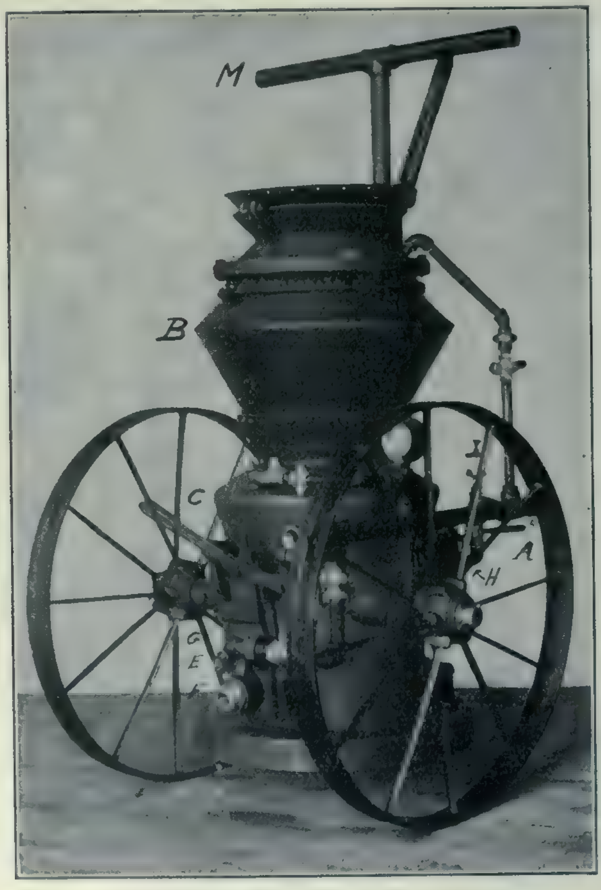


Fig. 1.—Modern type of cement gun.

Although the first principles were proven to be absolutely correct, the form of the machine and the method of operating it have been greatly improved. The greatest advantage of the new cement gun is its increased working capacity, which is about three times as much as that of the older type. The light weight of the new gun and the convenient arrangement of all its working parts also help very materially to reduce the cost of work. Cement guns have been used on the Panama Canal, the New York Central Terminal Station, the Woolworth Building, the Croton (N. Y.) Aqueduct, construction of large reservoirs in San Francisco and Nashville, in the Hawaiian Islands, for viaducts in Spain, and other work.

The cement gun fills an important field in engineering work for waterproofing, protection of steel, the lining of tunnels, reservoirs, shafts, ditches and canals, etc., and the repairing of disintegrated concrete, masonry and brick work. Although there is still a large amount of gun stucco work done on ordinary building construction, the engineering work is now decidedly predominant.

Operation of the Cement Gun

Fig. 1 illustrates the modern cement gun in working position. If to be moved, the machine is tilted over and by means of the handle bars, M, it is wheeled about like a cart.

The air line from the compressor is connected at A to the main air pipe, which by its branches conveys the air to the motor H, driving the feed wheel to the lower C and upper B material hoppers and to the main outlet valve GEF. At different points in the air lines the necessary cocks, check valves, boilers and pressure gauges are provided as shown.

The operation of the gun is simple. Fig. 2 shows a vertical cross section. The inside construction and the method of operation are easily understood from this drawing.

The material, which has been previously mixed dry in the right proportion, is thrown into the upper receiving hopper B which has a capacity of about 3 cu. ft. Then the upper cone valve is closed and compressed air is admitted so that the air pressure in hoppers B and C become equal.

By the weight of the material, the lower cone valve opens and admits the material into the lower hopper. Then the lower cone valve is closed. An air outlet valve in hopper B emits the compressed air and hopper B is ready for another charge.

In this manner the lower hopper C is always under equal pressure and continuous operation of the gun is made possible.

At the bottom of hopper C there is the cone-shaped feed wheel D, which has a number of small pockets equally spaced on its outer edge. This feed wheel is gear-connected to the air motor H, which keeps the wheel in continuous rotation. As the feed wheel rotates, it carries in its pockets measured quantities of material into the stream of compressed air entering at E, which blows the material into the delivery hose connected at F. The pockets on this feed wheel are so arranged that before the material is entirely fed out of one pocket, the feeding begins from the next one, so that the flow of material is smooth and even. J is an agitator revolving with the feed wheel. K is the large gear wheel connecting the air motor H. L is the foot rest and G is the shut-off valve with a by-pass which automatically cleans the hose.

---

* Abstract and re-arranged version of a paper presented last month to the Western Society of Engineers, Chicago, and published in the April journal of the Society. In co-operating with the Editors of the Contract Record in the reproduction of this paper (in two parts, in the issues of April 29 and May 6), Mr. Weber kindly offers to deal directly with any enquiries through our correspondence columns.

With the lower tank full of material, the operation of the machine proceeds as follows: Air is admitted to the air motor which starts the feed wheel in motion; the air line to valve G is then opened, but as the slide is closed the air does not enter the machine but escapes through the by-pass in the body of the valve out through the material hose, cleaning the hose and creating a suction which prevents clogging on opening the valve slide; this slide is then opened and the material begins to discharge at the nozzle.

The delivery hose is made of pure soft rubber covered with heavy canvas and may be 300 ft. in length and even more. It is usually made up in sections of 50 ft. each, united by special metal couplings. At the end of the hose line is the rubber-lined metal nozzle, which is also connected to a water hose in such a manner that a fine spray of water is added to the material as it rushes through the nozzle. A small screw valve enables the nozzle man to adjust the amount of water needed for the proper hydration of the material.

It is characteristic of the cement gun, and of greatest importance for the quality of the work, that the material is delivered "dry" through the machine into the nozzle, and that the necessary water for hydration is added at the moment of deposit. The hydration of the material really takes place in the air between the nozzle and the place of deposit and any loss of the binding power of the cement in transit is absolutely avoided. The initial set of the cement takes place on the structure and not in the mortar box. Another very important factor of the cement gun process is that only the proper amount of water for perfect hydration can be added because all superfluous water is expelled automatically by the force of impact of the material at its place of deposit. If we consider that the air in the cement gun does not act as a plunger in forcing the material through the delivery hose but carries the materials by suspension and skin friction, we can easily understand that only a dry material can be successfully conveyed by air pressure and that only a machine shooting dry material can be self cleaning and free from clogging and excessive wear.

The air consumption of the cement gun is very economical. An air compressor delivering about 40 cu. ft. of compressed air at 45 lb. pressure, which is equal to about 150 cu. ft. of free air per minute, is sufficient for the ordinary working capacity of the gun of say 1½ cu. yd. of dry material per hour. A larger volume of air at higher pressure will greatly increase the capacity up to a maximum of about 4 cu. yd. per hour. The working capacity of the cement gun depends upon many different factors. The experience of the crew, the kind of work to be done, and the method and thickness of the coating must be taken into consideration. The distance of delivery and the height of elevation, however, are of minor importance. As stated before, the capacity of the cement gun is up to 4 cu. yd. per hour, but if a thin coating is applied it is, of course, impossible to utilize more than a fraction of the gun's capacity under actual working conditions.

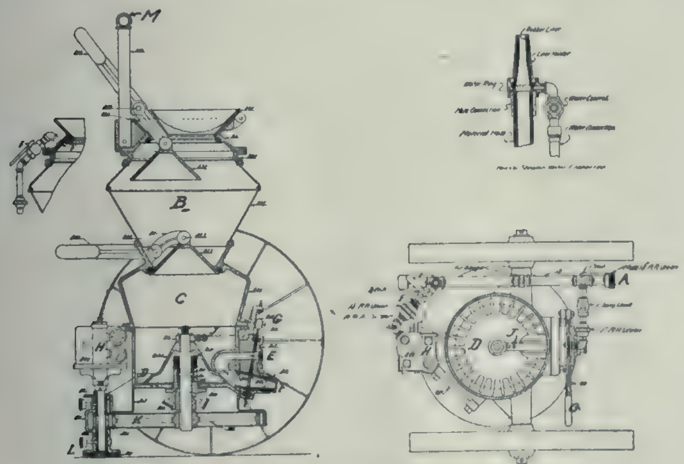


Fig. 2.—Construction details, modern cement gun.

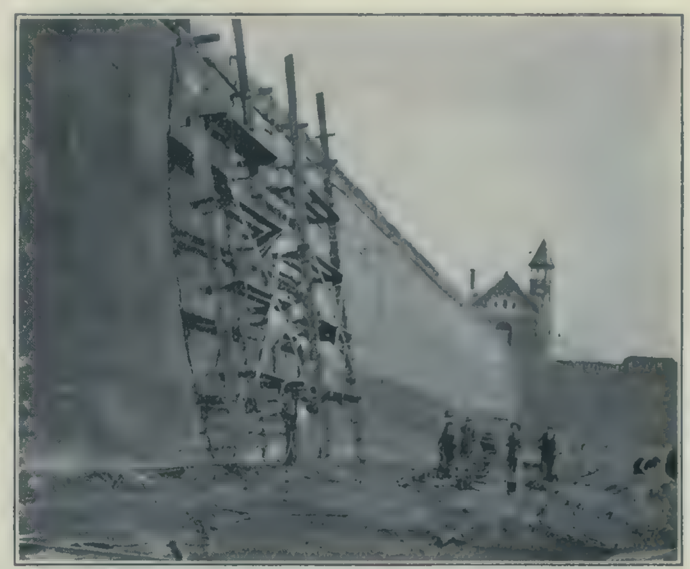


Fig. 3.—Cement gun in operation at Nashville.

In Fig. 3 the cement gun is shown in operation on a reservoir lining at Nashville, Tenn. The picture clearly shows the location of the gun, the working crew, and the form of movable scaffold used on the job. The upper man on the scaffold is handling the nozzle and the two different lines for water and material uniting at the nozzle can be readily distinguished. The workman on the bottom is cleaning the surface by washing it with a water jet of high pressure. The air compressor may be located wherever most convenient. It may be at practically any distance from the gun. The connection is made by a flexible hose or a pipe line, and although there is a certain loss of air pressure due to friction in the line, in practical work this can easily be compensated for, and the loss is a negligible amount.

Before the cement coat can be applied, it is usually necessary to clean the surfaces and different methods must be used to meet the special requirements. While scum and dirt in reservoirs can often be washed off, it is at times necessary to use a sandblast for this purpose; especially is this true on steel work. Before old masonry, concrete, or brick work can be coated, it is frequently necessary to deepen the joints or even roughen the entire surface removing all loose and decayed particles from the structure. For such work the cement gun process is doubly advantageous for the reason that the gun in itself is a most effective sandblasting machine. Both dry and wet sandblasting is done most advantageously with the cement gun while the powerful airblast can be utilized for removing loose dirt and duct. Air tools of all known varieties can be connected to the pressure lines and the flexible hose connections allow access to even the most concealed corners which could not be reached by any other method.

A good soft rubber-lined hose for this gun will give over a month of continuous service if used with care. For longer transportation lines and in straight sections which are not moved frequently steel pipes may be used. For curved sections, however, rubber hose is imperative, as a curved steel pipe will be worn out after a few hours' work. The rubber lining of the nozzle will last from one to two weeks. Without this lining the brass nozzle end would be destroyed in a short time. It is necessary that the hose be made of the most flexible pure soft rubber. Although such a hose is considerably higher in price than the ordinary varieties, it is by far the cheapest in operation owing to its lasting qualities.

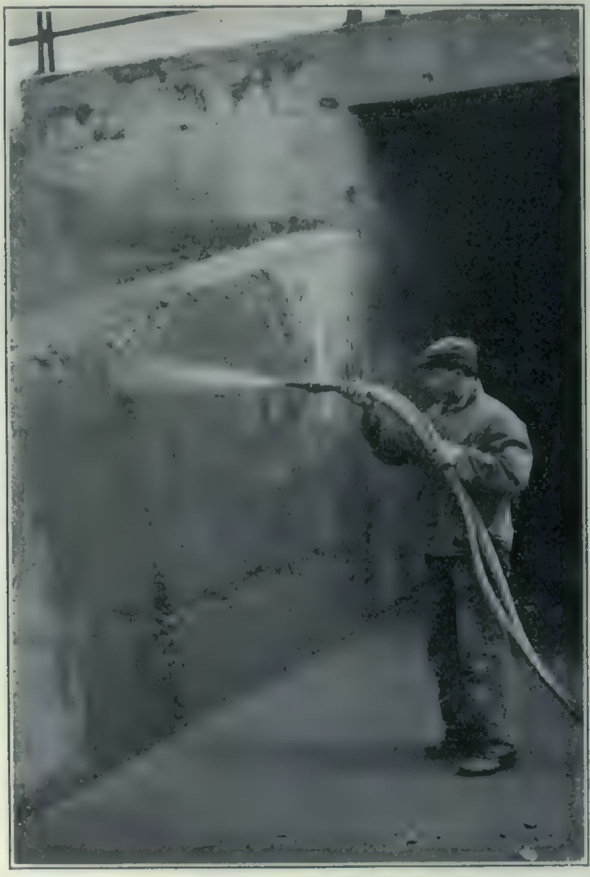


Fig. 4.—Gun nozzle in operation.

For general information it may here be added that the weight of a cement gun is about 1,100 lbs. Its height to the top of the upper hopper is 54 in. The wheels are 36 in. high, and the extreme width is 37 in. The air line from compressor to gun is usually 1¼ in. in diameter. The material hose is from 1 in. to 1½ in. inside diameter and the water hose to the nozzle is ½ in.

The air pressure is from 35 to 45 lb. per sq. in. and although an air compressor of about 100 cu. ft. capacity (free air) would suffice for all ordinary work, it is advisable to use a compressor of about 150 to 160 cu. ft. capacity. The cost of operating the larger compressor will be very little higher and is more than compensated for by the increased efficiency of the cement gun. A motor from 20 to 25 h.p. will be necessary for operating this compressor, and gas, steam, or electric power may be used as conditions suggest.

The working crew of the gun usually consists of four to six men, which are a foreman, two or three material men at the gun, and a nozzle man. This is all that is necessary for ordinary work. If, however, reinforcement is to be placed, or a special finish or surface preparation is required, the number of men must be correspondingly increased.

Gunite

Gunite is usually a cement mortar composed of about one part of Portland cement and three parts of coarse, sharp sand passing through a ⅜-in. screen. Although other compositions may be used and hydrated lime or any other ingredients may be added, it has been found in practice that the one-to-three cement and sand mixture is the most advantageous and efficient.

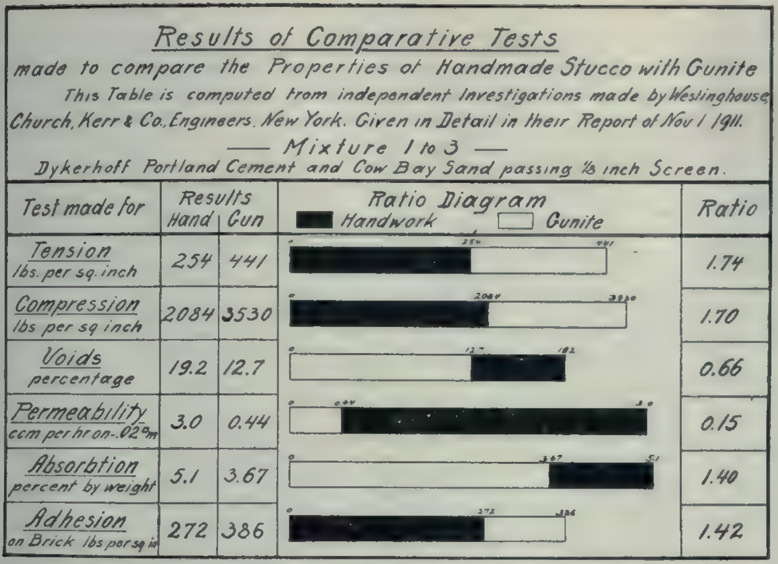
For ordinary stucco work on buildings, a one-to-four mixture is often sufficient, and even a still weaker mixture with a small percentage of hydrated lime added can be used if desired, or if utmost economy must be used on the work. For engineering work, however, the cement-sand mixture of one-to-three is mostly used without the addition of anything else.

To understand the advantages of gunite over ordinary cement work, it is necessary that we follow the process of formation of the deposit as it occurs on the surface to be coated. Fig. 4 shows the nozzle in action, and the method of shooting is clearly demonstrated in this view. After the wall surfaces have been prepared for the gunite coat by cleaning, or whatever other preparation such as tooling or the like was necessary, and after the reinforcement which is provided for the work has been placed, the stream of material is directed against the surface as shown.

The material leaves the nozzle with a velocity of about 300 ft. per second and as it strikes the hard surface the sand will rebound and fall down. Only the neat cement will first adhere until a coat thick enough to hold the sand has been formed. Then the rebound stops almost entirely and the coat is built up grain by grain until the required thickness has been attained. In this manner a film of neat cement is formed automatically between the old and the new work on every inch being covered, thus sealing every pore. Not only on the surface itself but also around every reinforcing bar or wire the same process takes place and thereby a bond is secured which cannot be obtained in any other way. No matter what kind of a surface is being covered, steel or wood, stone, concrete or brick, the first film of neat cement is sure to be there regardless of the amount of sand added to the cement mixture.

This point is of great importance and every engineer or architect will fully appreciate its value. We all know how difficult it is to bond cement to old surfaces that only an even coat of neat cement can give any assurance of success. In handwork, even in spite of most rigid specifications and inspection, it is practically impossible to get this bonding film applied in the proper manner and in the proper time. If applied at all it must of necessity be done ahead of the other work and be partially set before the actual coating is done, or even dry out and become worse than useless.

By the cement gun process this coat is formed automatically at the only moment when it is effective, and the most careless nozzleman could not omit it, even if he were paid a premium to do so. This bonding film



Results of Comparative Tests
made to compare the Properties of Handmade Stucco with Gunite
This Table is computed from independent Investigations made by Westinghouse, Church, Kerr & Co., Engineers. New York. Given in Detail in their Report of Nov 1 1911.
— Mixture 1 to 3 —
Dykerhoff Portland Cement and Cow Bay Sand passing ⅛ inch Screen.

Test made for	Results Hand	Results Gun	Ratio Diagram ■ Handwork ☐ Gunite	Ratio
Tension lbs. per sq. inch	254	441	0 254 441	1.74
Compression lbs per sq inch	2084	3530	0 2084 3530	1.70
Voids percentage	19.2	12.7	0 12.7 19.2	0.66
Permeability ccm per hr on -.02 $^{\circ}$m	3.0	0.44	0 0.44 3.0	0.15
Absorbtion percent by weight	5.1	3.67	0 3.67 5.1	1.40
Adhesion on Brick lbs per sq in	272	386	0 272 386	1.42

Table 1.

of neat cement is characteristic of gunite and is inseparable from its application.

As the "shooting" continues this forcing ahead of the neat cement by impact is continuously repeated, and every grain of sand which does not find a perfect bed or which is not immediately enveloped with cement will rebound and be forced out. Any pores remaining will be immediately filled by the following mass and all air and surplus moisture is forcibly ejected.

The amount of water in the mass is regulated automatically under all temperatures and weather conditions. If not enough water is used the gunite coat cannot adhere and all surplus moisture is expelled as demonstrated before. All the water regulation required by the nozzleman is to see that the gunite coat sticks without running; the rest is taken care of by the gun. The resulting gunite coating must therefore be uniform throughout, of greatest possible density, and of 100 per cent. efficiency.

Another factor of great importance is that gunite forms a perfect bond to the reinforcement which has been inserted in the coating, and at every place intimate contact between steel and concrete must exist. if, for instance, a thin cement coat is plastered by hand over a wire mesh or other reinforcement, the action of the float and trowel causes continuous jarring and vibrating of the steel within the cement mass, which is still further emphasized by the elasticity of the reinforcement and the suction under the trowel. In numerous places around the wires or bars, open spaces will be formed in which the wires lies without contact with the surrounding concrete. In gunite this is impossible for the reason that the mass is built up around each individual piece of the reinforcement without the slightest vibration, and a loosening of the steel within the coating is impossible no matter how thin the same may be applied.

These facts have been confirmed by field and laboratory tests by Messrs. Westinghouse, Church, Kerr & Company, engineers, New York. The tests were made to compare the qualities of handwork with gunite.

"In all of the tests made the product of the cement gun showed superior to good hand-made products of the same kind. The degree of superiority varied between wide limits. In tensile strength the gun work excelled hand work in every case by amounts ranging from 20 to 260 per cent. In compressive strength the excellence of the gun work was even more marked, ranging from 20 to 720 per cent. better than hand work. In the matter of surface permeability the gun work absorbed from 7-10 down to 1-20 as much water per hour, per unit of area as the similar handmade surface. As regards absorption of water, the hand-made mortars took up from 1.4 to 5.3 times as much as the gun-made mortars. The percentage of voids of the gun-made product ranged from 52 to 75 per cent. to that of the hand-made product. The adhesion of the gun-applied mortars was on an average 27 per cent. better than that of the hand-work."

In order to show, in condensed form, the comparative values of results of these tests, I have made a ratio diagram for the one-to-three mixture as given in Table I. In column 4 the black section indicates handwork and the light section gunite.

These tests, although they greatly favored the handwork, prove conclusively the superiority of gunite. The hand-made specimens were made with extreme care by expert union plasterers working under ideal conditions so far as material supply and everything else was concerned.

Consider for a moment how even the best hand stucco or plastering work is done in actual practice. Under most ideal working conditions it will be from fifteen to thirty minutes before the mortar is taken from the mixer to the wall. By the cement gun process the material is deposited within a fraction of a second after the water is added.

The cement gun gives a perfect bond and forms a

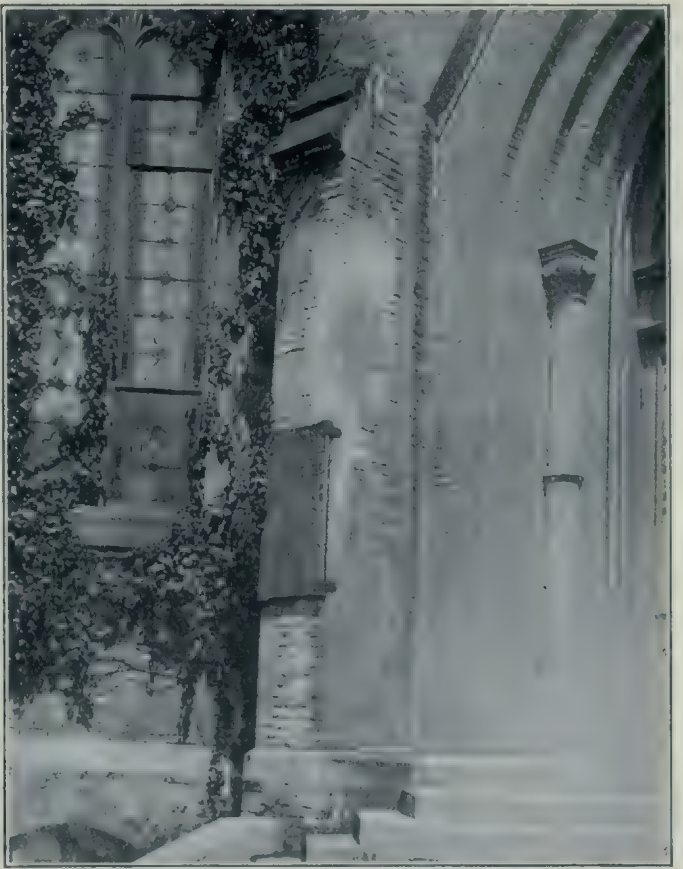


Fig. 5.—First Baptist Church, Evanston.

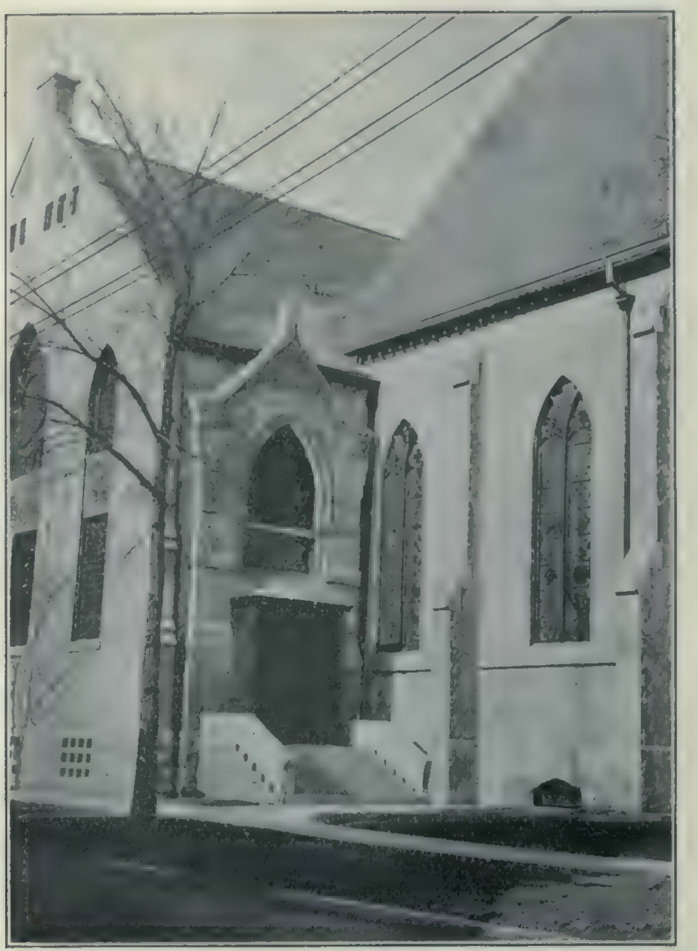


Fig. 6.—First Baptist Church, Evanston.

coating of a density which it is impossible to produce by any other known method.

Cost of Gunite Work

There is a great difference in weight between hand made concrete and gunite. Numerous tests have been made to ascertain correct values and it was found that the average weight of best hand made stucco after twenty-eight days was 131.04 lb. per cu. ft., while the weight of gunite made of the same mixture is 154.8 lb. Gunite is therefore 18.1 per cent. heavier, and of course requires correspondingly more material. In estimating gunite work this difference must be considered and also the loss of sand caused by rebound as mentioned.

The amount of rebound varies, depending upon different factors, as, for instance, kind of surface to be covered, thickness of conditions, etc. The loss will vary from 5 per cent. to 30 per cent., and although in most cases the sand itself is recovered and used again, the loss must be compensated in the original mixture so as to get the desired results. The amount of work which a gun will accomplish in an hour and its cost depends on so many different factors that it is impossible to estimate without definite data. As compared with handwork, we find that on large jobs the cost of a gunite coating is much cheaper, while on small jobs, where the initial expenses are high or where the equipment must be shifted frequently, the cost may be somewhat higher.

In many cases, however, it will be practically impossible to make any comparison with handwork for the reason that most of the work done by the cement gun, especially on engineering structures, cannot be done by hand. Even in plain stucco work, where practically standard methods are employed, the gun has a great advantage over other methods for the reason that a much lighter coating can be used. A ½ in. gunite cover is fully as efficient as a 1 in. hand stucco, and the saving in material will often more than equalize the cost of installing the apparatus.

Handling of Cement Gun Equipment

The cement gun is not more complicated than any other machinery used on construction work. In order, however, to get the full benefit from the machine it is necessary that at least two experienced men be employed with every gun. The first one acts as a foreman, and must know how to rig-up and manage the work for best results He must be able to take good care of his machine, men, materials and supplies, and should also have had enough experience with carpentry work to build such light scaffolds, swings, and forms as may be required for the work. The second man must be a good nozzleman, have a steady hand and a keen eye, and be quick in his movements. A poor nozzleman will waste considerable time and material, and although he cannot spoil the quality of the work, he may do great damage to the appearance of the same. On his skill depends the cost of the finishing work and the amount of material used. This, of course, applies to most any line of work. Buying a set of carpenter tools does not make a carpenter, and getting a set of drawing instruments does not make a draftsman. It is the experience and skill behind the tools which make them valuable. It is therefore important, in placing orders, to see that the work is done by experienced operators.

The Working Field of the Cement Gun

Within the last few years several distinctly different lines of work have been developed by the cement gun, and some of the more important branches of this work is here illustrated and described. A large number of brick, tile, stone, and wooden buildings have been coated with gunite with great success.

In Figs. 5 and 6 two views of the First Baptist Church at Evanston, Ill., are shown. This church had been covered previously with hand stucco which did not hold. Fig. 5 shows the appearance of the brick walls before the gunite coating was applied.

In order to remove the last of the old stucco and prepare the wall for the gunite coating, pneumatic bush hammers were used over the entire surface. The

Fig. 7. Showing how Gunite is applied to frame houses.

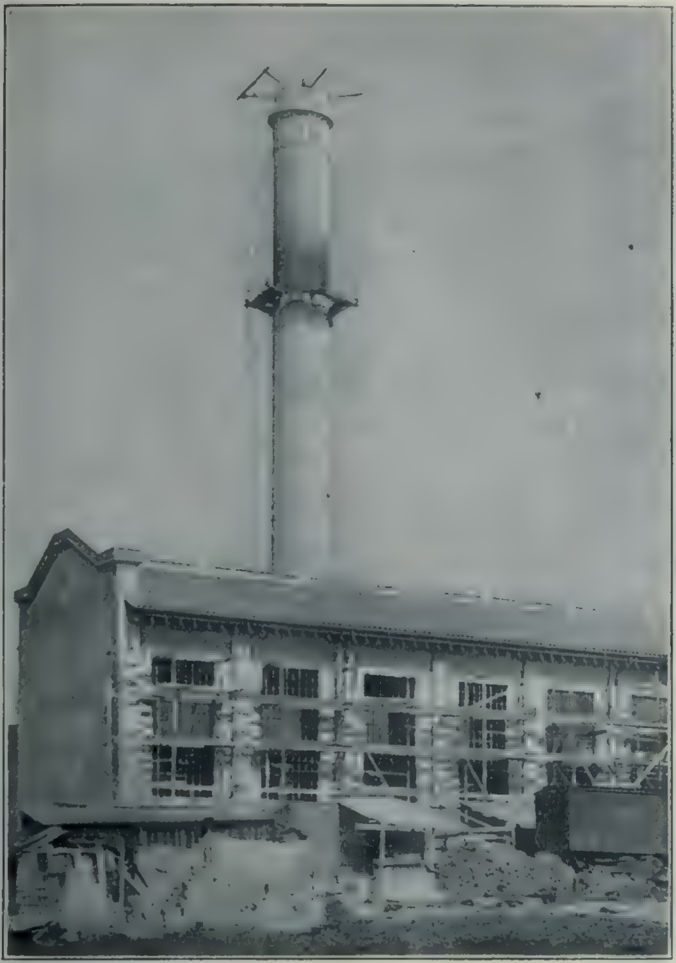


Fig. 8.—Reinforced concrete power house with Gunite coating.

materials for the gunite were limestone screenings and Portland cement mixed in the proportion of three-to-one. The thickness of the coating was about ¾-in. The limestone sills and trimmings of the church were also badly disintegrated and brought again to true lines, as shown in Fig. 6, which gives a partial view of the completed work. Numerous other brick buildings have been treated in a similar manner in all parts of the United States and elsewhere, among them being some very large warehouses at the New York docks.

Figure 7 illustrates how gunite is applied to frame houses. Hundreds of such buildings have been successfully coated and at a cost which allows most extensive use of the cement gun for this purpose. The house is at once made cooler in the hot summer days, and the cost of heating the house during the winter months is greatly reduced. The gunite coat reduces the fire risk and, being practically indestructible, will prolong the life of the building.

On all work applied to wood the gunite coat is reinforced with a light wire mesh which is nailed against the surface to be covered. The thickness of the coating is usually ¾-in. Any desired finish can be given, and frequently coloring matter is used in the last coat to good advantage. All parts of the building which are not to be coated, such as windows, cornices, etc., must be protected with tar paper, cloth or the like for the reason that it is difficult to remove unavoidable cement splashes. Fig. 8 shows a large reinforced concrete power house with chimney, the surfaces of which have been covered with a thin gunite coating to conceal the form marks and to produce a uniform finish for the entire structure. In this same view is a chimney 150 ft. high. The finish was applied with the gun standing at the ground level and the material was shot to the top without any inconvenience. This illustrates the carrying power of the cement gun and the adaptability and advantage of the machine for work difficult to approach. Only a very thin coat is usually required to cover the form marks and the bond is perfect without the employment of any artificial means. The gunite finish forms an integral part of the entire structure and at the same time waterproofs it effectively. It is conveniently applied to all surfaces as walls, floors, ceilings and roofs. For coating expanded metal and rib metal the cement gun provides an economical method. The cost of forms and scaffolds can be almost entirely eliminated on most of such work. The cement gun has been used for the construction of thin partition walls and hollow walls for buildings. For such work no forms are required except a light frame covered with building paper to hold the reinforcement in place and to act as a temporary backing. This framework is usually made of 2 in. by 4 in. uprights, spaced about 18 in. centre to centre. After the gunite has set, the frame may be removed and another finishing coat applied to the back, or the frame can be left in place. Often both sides of the frame are covered alike and a cheap and strong hollow wall is the result. A number of residence buildings have been erected where practically all cement work was done in this manner with the cement gun at a saving of cost over other construction which might have been employed. Figs. 9 and 10 show the gun work done on the new warehouse for the Illinois Steel Warehouse Company at St. Paul, Minn. The building is a steel and concrete skeleton structure and all the curtain walls between the frame work have been built by cement guns. These curtain walls are 2 in. thick and reinforced with No. 6A triangular wire mesh. A light wooden form was used on the inside as backing and to hold the wire mesh in place. The convenience with which the work was done is illustrated in Fig. 9, which shows the workmen standing on the hanging scaffolds. Two guns were in operation in order to finish the work in the shortest possible time to avoid the winter season. Fig. 10 shows a finished portion of the building.

Gunite has been used for the waterproofing of reservoirs, canals, aqueducts, bridges, basements, etc. The most important point in connection with such work is the fact that no ingredients or compounds are used which are foreign to concrete or which may gradually

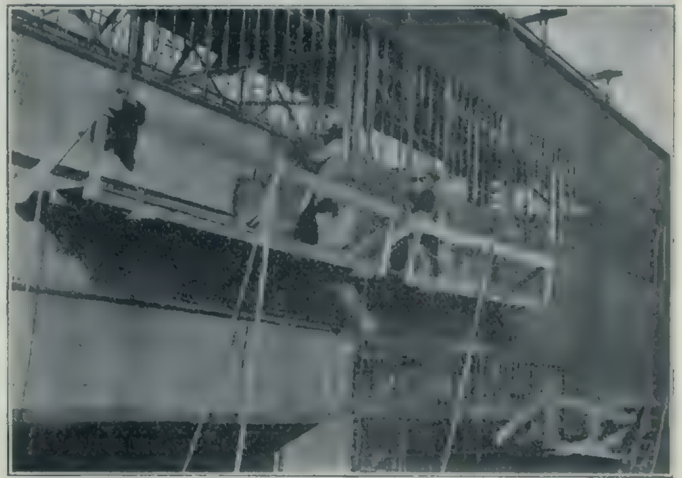


Fig. 9—Showing gun work on new warehouse for Illinois Steel Warehouse Company, St. Paul.

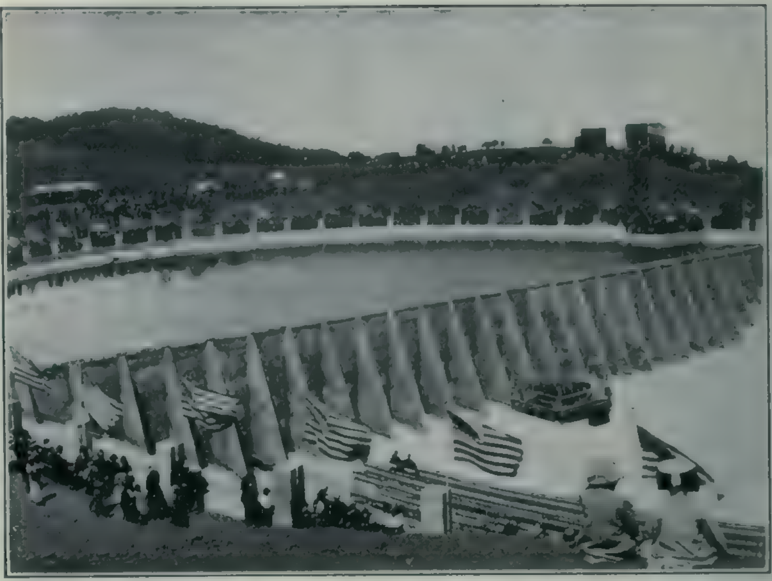


Fig. 11.—Twin Peak Reservoir at San Francisco.

deteriorate. Gunite consists of cement and sand only and is waterproof on account of its characteristic density. Fig. 11 shows the Twin Peak Reservoir at San Francisco. One-half of it is filled with water, while the other half, being perfectly dry, was used as a temporary auditorium. This reservoir is 370 feet long, 285 feet wide, and 27 feet deep, and when filled it holds 11,000,000 gallons. The partition wall is 1 ft. thick and is supported by buttresses placed 8 ft. apart on both sides. When the reservoir was first filled, it was found that in spite of all precautions taken, considerable water found its way through the wall, and therefore it was finally decided to use the cement gun for the purpose of waterproofing it. A coat of gunite only ¼ in. thick at the top and increasing to ½ in. at the bottom was applied on both sides of the partition wall and the buttresses. Immediately after the gun work was finished one-half of the reservoir was filled, with the result as shown.

Another large reservoir waterproofed with gunite is the water reservoir of the city of Nashville, Tenn. The work is shown in Fig. 3. The stone walls are 36 feet high. The reservoir is round, 463 ft. in diameter, and with a dividing wall as shown. This reservoir broke on account of seepage and had to be partially rebuilt. The inside and partition were waterproofed with gunite. This was also applied over the surface averaging 1½ in. in thickness, following the contours of the rough stone wall. The bottom was sealed with a concrete floor.

Another field which the cement gun has entered is the repair of such stone, brick, steel, and concrete structures as have developed weakness and have deteriorated under the influence of loads, water, and atmospheric conditions. In Fig. 4 we have already seen how this work is done.

Fig. 10.—Another view of St. Paul warehouse.

(Concluded in next issue)

A contract calling for 9,800 ft. of 36-in. flexible-jointed cast-iron pipe has been let in connection with New York City's Catskill water supply. The pipe is to be used in forming a siphon under the Narrows, the strait between Staten Island and Long Island, connecting the upper and lower bays. The submarine pipe line will carry the water supply brought from the Catskill aqueduct to Staten Island. On account of the traffic in and out of the port of New York the laying of the pipe, which aggregates 3,600 tons, involves unusual difficulties.

A Warehouse with Girderless Floors

A warehouse 100 x 271 feet, ten storeys in height, has just been completed at St. James Avenue and Arlington Street, Boston, for the Paine Furniture Company. The entire construction is of steel columns with concrete fireproofing and reinforced concrete slab floors up to the eighth floor. Above that floor the interior columns are reinforced concrete two feet round. Stiffener angles on the exterior steel columns, at the base of the column caps, support the floors, which are 8-inch slabs with multiple way reinforcement. The reinforcing rods are bent up near the columns to give shear compression to the reinforcement. The excavation began January 4, 1913. About 5,000 spruce piles were driven up to 30 feet deep to hard clay. Two steel derricks were set in the pit, each with 95-foot mast and 85-foot boom, and opposite them two concrete mixers were set up. Footings, basement floor girders and floor slab were concreted by the derricks, ¾-yd. buckets being used. Tar paper and tar pitch waterproofing were used over the footings and the basement floor. An inch of grout was used over the waterproofing, and on this the column bases were set, cast-iron for exterior and 6-inch steel slabs for interior columns. Exterior columns for the first floor were of one-storey height; all other columns, exterior and interior, were in two-storey length, breaking joints. Three-eighths-inch spirals wrapped all columns and were tied to four ¾-inch longitudinal rods, as bond for the concrete fireproofing. One set of forms for a complete floor with shoring frames was prepared. The column-head forms were made in two pieces, with a 6-foot hole for the cap form, and these were placed in position by the carpenters four or five days ahead of the floor panels (4 x 10 feet). Galvanized column and cap forms were used, the former two feet in diameter. Form work was kept three days in advance of the reinforcing and that three days ahead of the concreting. Floors were stripped about 48 hours after concreting and the same forms were used from the first to the top floor with but little patching. The last four floors were completed in 32 days.

The Control or Prevention of Stream Pollution

By Paul Hansen[*]

IN uninhabited or even rural districts the evil results of stream pollution are practically negligible, but in urban districts streams are rendered exceedingly foul by the enormous quantities of sewage and industrial wastes poured into them from city sewers. These streams become totally unfit for pleasure purposes, the land along the banks is depreciated in value, and public water supplies drawn from the streams may be grossly contaminated and constitute an extreme danger to public health. An enormous toll in human lives is annually exacted as a result of polluted streams, not to mention the economic loss due to depreciation in property values.

To prevent the evils of stream pollution gaining too great headway, central governmental control backed by an intelligent public opinion is essential. The molding of an intelligent public opinion is, however, a rather difficult matter, for even among persons who have given considerable thought to sanitary subjects, there exists gross misconceptions as to the logical and practicable way to treat the problem of stream pollution. There has been a tendency to permit sentimentality to get the upper hand, and this has resulted in giving wide currency to some extravagant demands that are wholly impracticable. There is, however, a group of sanitary engineers who have come into intimate contact with actual problems relating to the prevention of stream pollution, and among these engineers there has gradually come about a unanimity of opinion regarding certain essential factors relating to the stream pollution problem. It will be the object of this paper to present these opinions, and the statements made will be largely based upon recent careful inquiries among sanitary engineers and others interested in sanitation.

The subject may best be treated by first considering in a broad way what the functions of a stream really are. Having reached a satisfactory conclusion upon this point, it will be possible to consider certain special uses of streams with respect to stream pollution.

General Functions of Streams

The proper conception of a stream recognizes the dual function of watering and draining the country through which it passes. Some pollution of streams is inevitable; for with increased density of population, increased cultivation of the soil and increased numbers of urban communities, it is practically impossible to prevent the discharge of all deleterious matter into streams. It is only reasonable to require that the pollution of streams be maintained at less than a certain fixed maximum, and this permissible maximum pollution vary according to the character of the stream, the population along the banks of the stream and the uses to which the waters of the stream are placed.

Streams Used as Sources of Public Water Supplies

Since streams in the ordinary course of events must receive more or less contamination, it follows that public water supplies drawn from surface streams must of necessity be polluted, and should not be delivered to the consumers unless the water is first adequately purified. One exception may be made to this general rule, namely, in the case of water supplies derived from streams draining comparatively small watersheds. In such cases it is sometimes feasible for the water supply authorities to own the entire watershed and control it in such manner as to make contamination of the water courses impossible. But in general we have this question to contend with: How much pollution may be permitted to enter a stream before the water thereof is polluted to a point beyond redemption by water purification methods? This is a question that taxes the greatest ingenuity of sanitary experts, and it is always necessary for any specific problem to be considered on its particular merits in order to obtain what is the best and most economical solution.

Notwithstanding the great difficulty in defining that degree of pollution which is permissible in streams which are to be used as public water supplies after purification, there would seem to be an advantage in attempting to approximate a general rule for the control of such streams. A rule has been formulated in the light of the present available evidence, but it must be admitted that this rule is not based upon any very scientific data and it can, therefore, only be put forward tentatively, with the expectation that it will be modified from time to time as more and more experience is acquired. This rule may be stated as follows:

The time in hours required for the passage of a particle of water from a sewer outlet to the point of waterworks intake during high water multiplied by the dilution available during low water in cubic feet per second per 1,000 persons tributary to the sewers should equal a constant and this constant should not equal less than forty. This may be expressed mathematically as follows:

$$T + D = C.$$

In which $T =$ time in hours required for the passage of a particle of water from the sewer outlet to the waterworks intake at high water;

$D =$ dilution available during low water in cubic feet per second per 1,000 persons tributary to the sewers; and

$C =$ constant which it is recommended be not less than 40.

The above formula applies to streams in which there is no appreciable increase in volume of flow between the sewer outlet and the point of water works intake. In the case of streams which receive the discharge of large tributaries between the point of sewer outlet and the point of waterworks intake, the formula must, of course, be modified. Generally it will be merely necessary to assign a value of D, which represents the mean of the quantity of water flowing past the sewer outlet and that flowing past the waterworks intake. If the factor of safety proves to be more than 40, purification of the sewage will not be necessary for the protection of the water supply. If the factor of safety is less than 40, some form of purification will be necessary, and this may vary all the way from plain sedimentation to intermittent sand filtration followed by sterilization.

The formula, of course, is intended to be used merely as a rough guide, and it is conceivable that there are instances where it will not apply. Take, for example, the case of a very large stream, where a sufficiently large factor of safety may be obtained with the sewer outlet at a very short distance above the point of waterworks intake, and on the same side of the stream; here it is manifest, due to the impracticability of securing a mixture of the sewage with the entire volume of the stream, that the sewage must receive treatment or the waterworks intake must be extended to a point above or, at any rate, beyond the influence of the sewer outlet. As a rough guide, however, such a formula may serve a useful purpose in narrowing down the widely divergent practice of the present time.

---

[*] Engineer of the State Water Survey of Illinois

Streams for Recreation Purposes

Of recent years growing importance is attached to the maintenance of our streams for pleasure purposes. Every summer there may be found scattered along the streams within a radius of fifty miles or more of our large cities numerous camps. This form of summer vacation is a comparatively cheap and normally a healthful means of recreation. It ought to be regarded as one of the means of improving the health tone of our urban communities, inasmuch as it is within the means of so great a number of people.

Under this head may be asked how high a degree of purity should be demanded in a stream which is extensively used for recreation purposes, but not for public water supply? Within the last few years much emphasis has properly been placed upon the purification by oxygenation in which a natural resource is utilized instead of an artificially constructed purification works. It has generally been held—and in most instances rightly held—that the degree of dilution necessary is merely that which will prevent a nuisance, having reference primarily to unsightly floating matter and bad odors. For most rivers and many of the smaller streams of the country, this requirement as to the cleanness of the waters is all that is necessary.

There is, however, a certain class of streams which, because of the beauty of the country through which they flow and their specially favorable location, become highly prized for camping and recreation purposes. It is a striking circumstance, in fact, that recreation seekers nearly always look for the stream valleys, which illustrates the craving of man for a combination of land and water, by means of which nature presents her most alluring and most picturesque aspects. These streams, as a rule, have no large cities upon their banks, but merely here and there a small town or village. The sewage from such small towns and villages may not be sufficieent to produce a visible contamination except possibly throughout a very short distance below the sewer outfalls. Such contamination does offend the aesthetic sense, however, and undoubtedly does add some danger to public health, for the reason that, when a stream is used for recreation purposes, it will be used for boating and bathing and as a domestic supply to some extent among campers, though it may not and should not be used for drinking water. It seems to the writer that such streams as these deserve greater protection against contamination than merely to prevent nuisance.

No definite rules to apply to all cases can be laid down, but as a general principle it may be said that if such a stream is not polluted to any material extent by storm water and street wash, such as would obtain in the case of a city of considerable size located upon its banks, it would seem perfectly feasible to purify the sewage to a point where it will give no evidence of its existence even in the vicinity of the outlet. Furthermore, the sewage effluent should be sterilized by the cheap and satisfactory means of using bleaching powder, so as in large measure to guard against dangers to health among vacationists which may result from boating, bathing and domestic uses of the stream other than for drinking.

Fish and Shell Fish

Many streams are valuable to the community on account of their fish life. It may be said, in general, that there is rarely necessity for so polluting a stream as to endanger fish life, though there are some circumstances where the continuance of certain liquid-waste-producing industries injurious to fish is of so great importance to the general welfare that fish life in certain streams must be sacrificed.

The maintenance of fish life does not necessarily imply an unpolluted stream. It is merely necessary that the alkalinity of the water be maintained and that the pollution be not so great as to absorb the dissolved oxygen in the water to an extent that will suffocate the fish. The fact is that a moderate degree of pollution favors fish life, in that it favors the growth of microscopic aquatic organisms which constitute valuable fish food. Certain difficulties have been encountered in the contamination of fish by polluted water which causes the fish to decay rapidly and become unfit for human consumption. The danger of infection of human beings with specific disease through eating fish taken from polluted streams is almost negligible, for the reason that, in this part of the world at any rate, fish are not eaten raw. With shell fish, however, the case is quite different, because they are very frequently eaten raw. It has been a common practice along the coast to float oysters in shallow polluted waters, which causes them to become bloated and appear fat. Such an oyster perhaps makes a more delectable morsel of food, but in it may be lurking the germs of typhoid fever or some other water-borne disease. The problem of protecting the shell fish industry is a very complicated one, and all its intricacies have not been worked out. Here again the services of experts are needed to study each zone of shell fish pollution in the light of diverse local conditions.

Discharge of Manufacturing Wastes Into Streams

Many of our important industries, such as paper mills, woollen mills, dye works, starch factories and tanneries require large volumes of water to carry on their industrial operations, and they also produce large volumes of waste which are capable of undergoing offensive putrefaction. The discharge of these wastes into streams often causes unsightly and malodorous conditions; yet, with the exception of tanneries, these waters do not menace the public health, since they do not contain the specific infections of disease. (Tannery wastes may contain anthrax bacilli). In fact, some of the processes are such that the wastes are quite inimical to the existence of disease germs. In some cases it is practicable to treat the wastes so that offensive conditions in a stream may be in part or wholly relieved, but for certain industries such treatment of the wastes is prohibitively expensive.

Enjoining industries against causing objectionable stream pollution may, and in some instances actually has, necessitated the shutting down of works. It is conceivable, in the case of large industries upon which are dependent a considerable population, that an order to cease stream pollution, which is virtually an order to shut down the works, might result in great hardship without adequate returns accruing from the cleaner conditions of the stream. There may be instances, therefore, where a limited few of the streams of the country may legitimately be turned over to the manufacturing interests. Now that the stream pollution problem has become more acutely an issue and the disadvantages of filthy streams are better understood, it would not seem wise to permit waste-producing industries to be located upon any but very large streams which have an ample volume to dilute the wastes to an inoffensive condition. That is to say, the streams which are now clean should be maintained clean, for the reason that we have an ample number of large streams which can effectually take care of wastes from waste-producing industrial plants for an indefinite period in the future.

Typhoid and Paratyphoid Along the Richelieu River

By Theo. J. Lafreniere[*]

DURING January and February, outbreaks of typhoid and paratyphoid fever occurred in 10 of the 14 municipalities bordering the Richelieu River. The outbreaks have not been severe, although the number of cases has been rather large, the death rate being low for a paratyphoid epidemic. Several cases of true typhoid and paratyphoid have been reported and checked by the agglutination test, but in two municipalities, the symptoms would indicate severe intestinal troubles only.

Paratyphoid is not a reportable disease in the Province of Quebec, and the Board of Health became aware of the conditions along the Richelieu River, through the examination of the water-supply of Chambly Canton. On February 26, complaints were made, that the carcase of a dead animal had been thrown over the water intake of that town, and the inspection revealed that intestinal troubles were prevalent in the town. Inspectors were immediately sent to the various towns bordering the river, above and below Chambly Canton, and it was discovered that in 8 municipalities there had been numerous cases of typhoid and paratyphoid, since January, 1914. The outbreaks having started one and two months before the inspections were made, and the character of the disease being mild, it has been difficult to obtain exact data on the first cases. However, the information secured, given briefly in the table below, shows clearly that the outbreaks have been caused by the river water.

TYPHOID AND PARATYPHOID IN TOWNS ON THE RICHELIEU RIVER, WITH SOURCES OF WATER-SUPPLY

Town	Population, 1911	Cases of		Deaths[†]	Water-Supply	Approx. date first case
		Typhoid	Paratyphoid			
St. Johns	5900	14	260	3	River	3rd week Dec.
Iberville	1900	....	60	...	River	3rd week Dec.
Richelieu	330	1	15	...	River	4th week Dec.
Chambly Canton	860	2	20	1	River	4th week Dec.
Chambly Bassin	900	3	25	4	River	4th week Dec.
Beloell[*]	1500	....	....	...	Springs	4th week Dec.
St. Hilaire	1300	....	....	...	Springs	....
St. Charles	890	a few	35	...	River	2nd and 3rd week Jan.
St. Marc	950	a few	25	...	Springs and river	2nd and 3rd week Jan.
St. Antoine	1400		numerous	...	River	2nd and 3rd week Jan.
St. Denis	730		numerous	2	River	2nd and 3rd week Jan.
St. Ours	620	....	2	...	Springs	....
St. Roch	820	1	....	...	Tubular wells	....
Sorel	8400	8	84	8	River	January ....

[*] The Explosive Works, at Beloeil, use river water; 12 cases among employees, 10 cases have been discovered among families having private supplies with intake in the river. [†] From typhoid and paratyphoid.

St. Johns and Iberville, where the first cases appeared, are situated on each side of the river, and Rouses' Point, 22 miles above, is the first town on the river. Twelve and 18 miles above St. Johns, there are two small towns having no sewerage systems which are connected with the river by small streams flowing into the Richelieu. No typhoid cases occurred in those towns in December, 1913, and January, 1914. One of Iberville's sewer outlets is a very short distance below St. John's water intake, on the other side of the river, and it is possible that frazil ice which forms above the rapids immediately below St. Johns might have caused the sewage from Iberville to flow on the St. Johns side and contaminate the water intake.

During the first week of March, all the municipalities were notified that the water should be boiled, and five towns have already installed temporary plants to treat the water with chloride of lime. The epidemic is now (March 30) under control, and at its next meeting the Board of Health will decide what measures should be taken to prevent similar outbreaks in the future. It is expected that rapid filtration will be required for the largest water-supplies, and chlorination for the others. Paratyphoid will probably be added to the list of reportable diseases.

The water of the Richelieu River has been analyzed repeatedly since 1909, and the results sent to most of the municipalities. The river is contaminated by the sewage of the bordering towns, and above St. Johns, B. Coli is present in 1 c.c. The bacterial count, however, is relatively low.

The powers granted to the Board by the Quebec Public Health Act, of 1900, are not retroactive, and it is necessary to proceed under the general clause for nuisances, which is rather general, to force the older towns to improve their water-supplies. However, no trouble is anticipated from the towns on the Richelieu River.—Engineering News.

One of the simplest hard cements is the well known mixture of litharge and glycerin made to a stiff paste. It sets hard as a rock and is oil proof. A solution of water glass mixed with powdered calcium carbonate serves the same purpose. A mixture of boiled linseed oil and fire clay resists acid better than most cements, though sulphur melted with glass powder is also ranked as very resistant to chemicals in general. A good stone cement is made by mixing two parts of magnesium oxide, one part of magnesium chloride, powdered stone to suit as filler and water to make a stiff paste. Basic magnesium chloride is formed.—Scientific American.

---

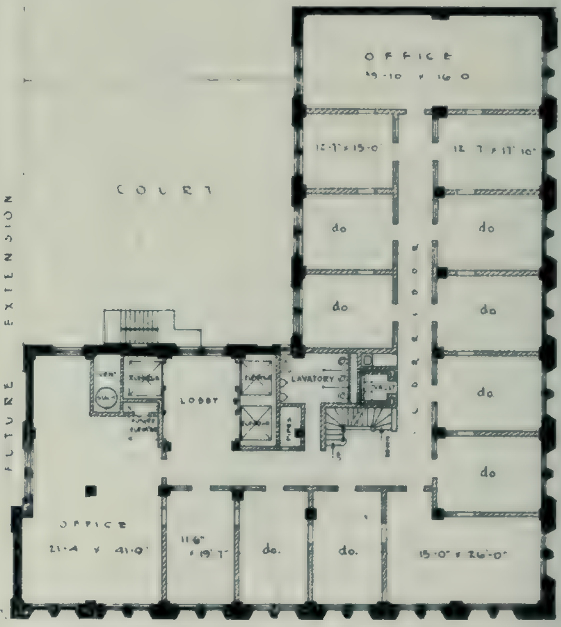
[*] The author, Mr. Lafreniere, (Montreal) is Sanitary Engineer to the Board of Health of the Province of Quebec.

Constructional Features of the Herald Building at Calgary

(Contributed by the Calgary Correspondent of the Contract Record)

PROBABLY the most notable structure erected in Calgary during the past year is the ten-storey office building completed recently for the Herald Publishing Company, one of the properties of the Southam Estate. In its architectural beauty and excellent planning the building is particularly notable, besides being the tallest office building between Winnipeg and Vancouver, as well as one of the tallest reinforced concrete structures in the Dominion. The building occupies a site on the corner of First Street West and Seventh Avenue, diagonally opposite the store of the Hudson's Bay Company. As land values are already very high at this point and are steadily increasing, an effort has been made to gain more than the ordinary amount of rentable area without sacrificing the essential conveniences of the modern office building. The plot of ground is 100 ft. by 130 ft. and of this area the present structure covers a plot 100 ft. by 92 ft. only. The three lower floors cover the entire area built upon, but above the third floor the building is L-shaped, providing a light well 50 feet by 60 feet for the future addition, 28 ft. by 100 ft., necessary to utilize the total area of the lot. The owners have occupied portions of the basement and three lower floors for the publication of their daily newspaper, and in addition there are two stores on the ground floor and 22 offices on the second and third floors. There are seventeen offices on each of the upper seven floors, making a total of 141 offices for rent. In the event of so great an increase in land values as to render the land tax on the publication of their newspaper prohibitive, the owners anticipate vacating the building for publishing purposes, and to this end the beams and floors are so arranged in the ground floor as to permit alteration for a minimum cost.

The Herald Building, Calgary.



Typical office floor plan, Herald Building, Calgary.

The construction throughout is of reinforced concrete, except certain beams and floors in the lower storeys, and the exterior walls are of brick. The street elevations are designed in the style of English Gothic, modified to suit the type of building, the masses being faced with a light brown tapestry brick, with terra cotta details and trimmings in buff. The rear and light court walls are all faced with white hollow brick. All exterior walls are backed with 8 inches of common brick. The top of the parapet is 132 feet above the street grade and there are a penthouse and observation tower rising another 25 feet above the parapet. The total height from footings to top of tower is 172 feet. The reinforced concrete design was made by the Corrugated Bar Company, of St. Louis, who supplied the steel. In general the columns are spaced 12 ft. by 13 ft., there being a total of 48 columns in the typical floors. The framing is the beam and girder construction with "Corr-Tyle" floors in part and solid slabs in the balance of the floor system. A total of 4,700 yards of concrete were placed, with 300 tons of reinforcing steel. The aggregate used was an excellently well graded river gravel. The contractors, in placing this amount of concrete, used a one-cubic-yard Smith mixer, discharging into an Insley hoisting bucket, thence into an Insley hopper, whence it was carted to the forms in wheelbarrows, the maximum distance being about 90 feet.

The Herald Publishing Company occupy about 16,000 square feet of floor space in the three lower floors and the basement. In order to accommodate the press in the basement, it has been necessary to raise the level of the ground floor over an area of about half the building, and so as to change the floor level to the street level, if necessary, the whole of this floor is carried on steel beams, with laminated wooden floors, supported on brackets on the columns. The press is the largest in Western Canada, and has a capacity of 30,000 32-page papers an hour. The mailing department is also in the basement and is served from the press by a conveyor. The editorial offices are on the second floor, together with private branch telephone exchange, telegraph office. library, and lavatories. The composing room is situated on the third floor, where, in addition to the linotypes, are a rolling machine, three pneumatic steam tables, double pump metal pot with two casting boxes, and a plate finishing machine capable of handling six plates a minute. Copy is carried from the editorial rooms to the composing rooms by pneumatic tubes, and the finished plates are carried to the pressroom by a hydraulic lift. On the ground floor there are two stores, one of 2,500 sq. ft., and another of 800 sq. ft. On each of the typical floors there are seventeen offices, aggregating 4,200 sq. ft., or 67½ per cent. of the total floor area, 6,200 sq. ft. There is a total of 80,000 sq. ft. in the building, including basement and sidewalk vaults, of which some 65,000 sq. ft. are revenue-producing, practically 80 per cent. Three elevators serve the building, which is in the proportion of one car to each 25,000 sq. ft. The entrance lobby and elevator lobbies are finished in marble, while the corridors have 6-foot cream terra cotta wainscotting, with plaster walls above. The floors of all corridors and lobbies are terrazzo, while the office floors are maple. The interior trim is white oak. On each floor there is a toilet, a vault with private safety deposit boxes and a mail chute. Each office is supplied with hot and cold water, filtered drinking water, and there are outlets also for gas and for compressed air for the use of physicians and dentists, besides outlets for the vacuum-cleaning system.

The building is heated by a Webster modulating low pressure steam heating system, supplied by two 125 h.p. return tubular boilers, gas-fired, with two Burnham boiler feed pumps cross-connected to one cast iron receiver, and two Burnham vacuum pumps. The premises of the owners are mechanically ventilated, requiring an air washer with a capacity of 15,000 cu. ft., with centrifugal pump driven by a 3 h.p. motor, and with one 54-inch intake fan, and one 42-inch exhaust fan, manufactured by the American Blower Company. The press room is ventilated by one 36-inch disk fan. The water filter is a 50-inch Roberts filter, having a capacity of 3,300 gallons an hour. The vacuum-cleaning system was installed by the Tuec Company, Limited, and has one 4-inch main. The elevators have cars 6 ft. square, with a normal express speed of 550 ft. a minute, and are electrically-driven, Otis Fensom elevators. One machine runs to the basement and two run to the observation tower. Provision has been made for installing a fourth car in this battery, in case the building is enlarged as outlined above, by removable slabs over the shaft. The large amount of power required has necessitated a transformer station in the basement. A high pressure fire system using a Fairbanks-Morse motor-driven pump, with automatic control, and a working pressure of 90 lbs. per sq. in., has also been installed.

The general contractors were Fyshe, McNeill, Martin, Trainer, Limited, of Calgary. Other contracts were as follows: Plumbing, heating, and ventilating—H. Kelly & Company, Limited, Calgary; electrical work—L. K. Comstock & Company, Limited, Toronto and Calgary; plastering—J. A. H. Lake Estate, Calgary; ornamental iron—Alberta Onamental Iron Works, Limited, Redcliffe, Alta.; interior woodwork—Emil Carlson, Minneapolis; sheet metal work and roofing—D. R. Foulds, Limited, Calgary; hollow metal windows—A. B. Ormsby, Limited, Toronto; floors and marble work—Flesher Marble & Tile Company, Limited, Calgary. The architects were Messrs. David R. Brown & Hugh Vallance, Montreal, for whom Mr. A. E. H. Herschel is the Calgary representative.

Methods and Costs of Encasing Steel Structures in Concrete to Prevent Corrosion

TWO methods of encasing steel structures in concrete, namely encasement by pouring and encasement by cement guns, are discussed in one of the appendixes of the report of the Committee on Steel Structures of the American Railway Engineering Association. The report states:

(1) If the floor is protected by concrete encasement where traffic is heavy and ordinary plank floors rapid-poured in place, the cost will be approximately 25 cents per square foot for an envelope 3 inches thick.

(2) Encasement 3 inches thick placed by cement gun will cost approximately 23 cents per square foot.

Specific samples of concrete encasement work are quoted as follows from W. F. Jordan, manager Grand Central Terminal Improvements, New York Central & Hudson River R. R., and from G. E. Tebbetts, Bridge Engineer, Kansas City Terminal Railway:

Grand Central Terminal

The cement gun is being used at the Grand Central Terminal for fireproofing and protecting a part of the steel structure. The yard is in two storeys, the upper tracks being supported on a steel structure with concrete jack-arches. It was necessary to get the upper tracks in service at an early date, so the fireproofing of the exposed parts of the steel below the pack-arches was not done at the time the floor was built.

The lower parts of the beams, the girders and columns are now being fireproofed with the cement gun, using a minimum thickness of 2 ins.; the average thickness is from 2½ to 3 ins., as in the angles and around the stiffeners there is generally more than the minimum thickness.

The fireproofing is reinforced with a wire mesh. 1½ x 1½ ins. of No. 12 wires; this is attached to ¼-in. rods, which are bent around the steel and fastened to it.

The mixture has generally been 1 to 3, but in cool weather, and where the steel is subject to vibrations from the trains running on it, a 1 to 2 mixture is found to be more economical, as it is not as likely to drop off. It is necessary with this machine to use fine sand, as sand with pebbles in it clogs the hose; all of the sand, therefore, has to be carefully screened.

We find that a cubic foot of 1 to 3 mixture, when weighed in a box of 1 cu. ft. capacity after being moderately shaken down, weighs 93 lbs.; if this mixture is wet and applied with a trowel, after setting it will weigh 127 lbs. to the cubic foot, when shot through a cement gun onto a steel structure and set up, it weighs 144 lbs. per subic foot. From this one gets an idea of the density of the fireproofing made with this apparatus.

In applying the mixture of sand and cement with the cement gun from 20 to 25 per cent. of it is lost Some bounces off as it strikes the structure, some is shot by the steel in working around the angles and to get a smooth surface the mason scrapes off the irregularities, and to get a good surface it is floated.

The labor required to operate one machine is as follows: 1 foreman, 1 operator of the machine, 1 nozzleman, 2 masons for floating, 4 laborers screening, mixing and charging the machines. Carpenters are used when necessary to erect scaffolds.

One of these machines uses compressed air to the amount of 100 ft. of free air per minute at a pressure from 35 to 40 lbs. The hose through which the mixture is conveyed wears out quite rapidly and renewals amount to about $1 per day. We have averaged covering about 500 sq. ft. per day of the thickness mentioned above. This method would appear to give an excellent protection for the steel. The material is very dense and the method of application such that every inch of the structure is uniformly protected. The great thickness used in this work is due to the municipal laws requiring at least 2 ins. of fire protection.

Kansas City Terminals

In the new structures, which the Kansas City Terminal Railway Company is building, the encasement is applied in the majority of cases by use of the cement gun. This machine consists essentially of a hopper into which the cementitious materials, made up of 1 part Portland cement to 3 parts dry screened sand, are placed; a hose connected to the bottom of the hopper, through which the mixture is forced by air pressure; a nozzle at the end of the hose, to which another hose supplying water is attached for hydrating the materials. At the end of the hose is a cylindrical nozzle having an annular ring at its base, to which the hose delivering the water is attached. This water is delivered inside the nozzle in the form of a fine spray, through which the materials from the gun pass. The nozzle is made of brass, and to prevent wear on the nozzle proper a rubber lining is used. This lining can be replaced whenever necessary.

Before adopting the cement gun, the claims of the company selling it were investigated and test panels were encased. The conclusion reached was that if the cost was not too great, it would solve the problem of encasement. Comparative estimates made are shown below:

Encasement by Pouring in Forms.—Encasement to be 3 in. in thickness; mixture to be 1:2:4 concrete; reinforcement, wire mesh and bars.

Stone, 1 cu. yd. at $1.25	$1.25
Unloading 1 cu. yd. at 20 cents	.20
Loss in handling at 5 per cent.	.07
Sand, ½ cu. yd. at 60 cents.	.30
Unloading ½ cu. yd. at 6c.	.03
Loss in handling at 5 per cent.	.02
Cement, 1¾ bbls. at $1.25	2.19
Unloading 1¾ bbls. at 5 cents	.09
Loss in sacks at 5 per cent.	.03
Total	$4.18

1 cu. yd. equal to 108 sq. ft., 3 in. thick.

Cost of material per sq. ft.	$0.039
Forms, $1.63 B. M. at $0.050	.081
Mixing and placing at $5.40 per cu. yd.	.050
Insurance on payroll at 5 per cent.	.003
	$0.173
Overhead and profit at 8 per cent. + 15 per cent. = 23 per cent.	.040

Cost per sq. ft. of encasement = $0.216.

Encasement per sq. ft.	$0.216
Mesh No. 3 at $0.06	.018
Bars, No. 5, at $0.03	.015
Total cost per sq. ft.	$0.249

Say, 25 cents per square foot.

Encasement by Use of Cement Gun.—Encasement to be 3 ins. in thickness; mixture 1:3 mortar; reinforcement, wire mesh and bars. Average number of square feet covered in a day of 10 hours, 275 sq. ft. Loss due to gun work, 20 per cent. Loss due to handling sand, 30 per cent. Quantity of sand used in placing 275 sq. ft. 3 ins. thick, 4 cu. yds.

Sand, 4 cu. yds. at $0.60		$2.40
Unloading and screening 4 yds. at $2.51		1.00
Cement, 5½ bbls. at $1.25		6.88
Unloading 5½ bbls. at $0.15		.83
Loss in sacks at 5 per cent.		.11
Water, per day		.15
Gasoline for compressor, 12 gals. at $0.15½		1.86
Oil waste and handling per day		.60
		$13.83
1 foreman, 10 hrs., at 37.5 cents		$3.75
1 finisher, 10 hrs., at 35 cents		3.50
1 nozzleman, 10 hrs., at 32.5 cents		3.25
1 gunman, 10 hrs., at 30 cents		3.00
2 laborers, 10 hrs., at 22.5 cents		4.50
1 boy, 10 hrs., at 12½ cents		1.25
		$19.25
Repairs, etc., per day	$2.00	
Scaffolding for 275 sq. ft. at $0.15	4.13	
		6.13
Interest on gun, $3,000 at 5 per cent.	$0.41	
Insurance on payroll at 5 per cent.	.97	
		1.38
Total		$40.59
Overhead and profit 8 per cent and 25 per cent = 33 per cent		13.53
Cost of encasement		$54.12
Cost per sq. ft.		$0.1968
Mesh No. 3, per sq. ft. at $0.06		.018
Bars, No. 5, per sq. ft. at $0.03		.015
		$0.2298

Say, 23 cents per square foot.

A comparison of the above shows a saving of 2 cents per square foot in favor of the gun work over the poured encasement, and it might be stated that since this estimate was made we have received bids on actual work that check very closely with the above.

The steel work to be encased was designed with open holes 11-16 in. in diameter in webs, stiffeners and flanges, so that in placing and attaching the reinforcement there would be ample provision for rigid attachment to the structure. In attaching reinforcement to girder webs and other large surfaces, the bars were placed on small V-shaped iron saddles and wired through the webs to each other. On flanges the rods were run through steel eyebolts attached to the lower flange, the mesh being attached to the bars by wiring. At the junction of the concrete encasement with the floor, which is also of concrete, a splice was provided by use of mesh placed in the floor previously cast, this splice being four inches in width. Fig. 1 shows typical method of attaching reinforcement to girders.

The steel girders were shipped from the shops with a shop coat of linseed oil, which was removed by the use of a caustic soda wash before encasement was started. All rust spots were removed with a wire brush.

Our experience has shown that the 1:3 mixture placed in the gun gives a resulting mortar of approximately 1:2½, this change being due to loss of sand. The sand must be nearly dry, the dryer the better, a mixture of coarse and fine grains giving better results with considerably less loss, than either the coarse or fine alone.

The sand must be screened as particles over ⅛ in. in diameter clog the gun and cause serious delays.

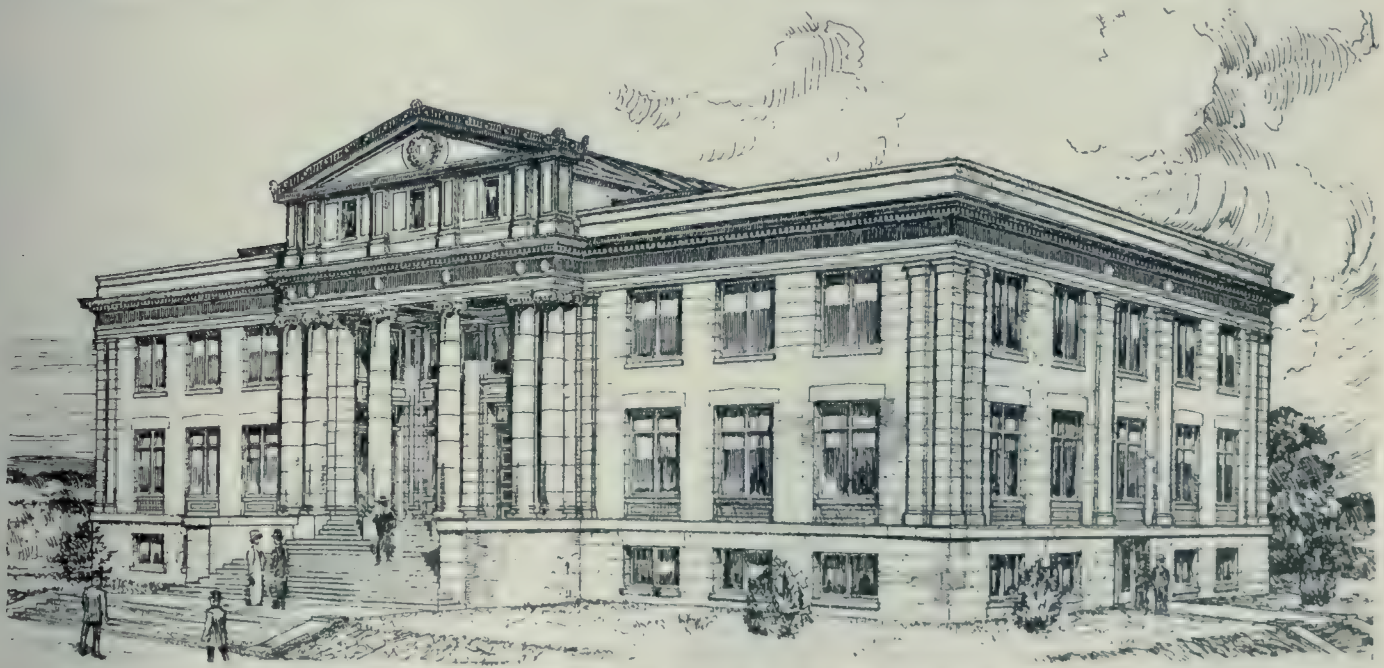
The compressor should be a machine of very ample capacity and an intermediate air storage tank is an advantage.

It was found that it was very difficult to encase the lower flange of a girder, especially so the lower face, and in our work we cast this portion in quite a few cases.

It was also a difficult proposition to get a good, clean job around stiffeners and sidewalk bracket members. On the brackets V-shaped forms were made and used as a backing for the gun work. As to finish, the appearance is fairly good, though far from the smooth, even lines of cast work and a great deal depends upon the finisher as to the final appearance.

The New Courthouse at Vernon, B. C., and Other Structures

Among the number of important constructional undertakings in British Columbia for which the well-known Vancouver and Victoria firm of Thos. Hooper has acted in an architectural capacity is the new Court House at Vernon upon which the work of construction is now rapidly approaching completion. This building, consisting of four floors, occupies a commanding situation at the corner of Mara Avenue, Barnard Avenue and Eighth Street facing west, with the main entrance on Mara Avenue. The treatment followed in the design is Columar Ionic with a dignified main entrance portico paved with marble squares. The construction consists of reinforced concrete for the columns and floors, with exterior facing of local granite, the pitched roof and cresting of pediment being covered with copper. The pedestals at each side of the main entrance steps are surmounted by cast bronze candelabra. The provincial coat of arms has been placed over the main doorway, the doorway itself being of oak suitably carved. Marble wainscotting and terrazzo floors are features of the vestibule and corridors. The interior finish generally is executed in fir. The most outstanding feature of the interior design is the Supreme Court room which measures 50 x 75 feet over the galleries. This apartment has panelled wainscotting to the height of the galleries and is treated with pilasters extending from floor to ceiling, the latter being heavily enriched with plaster work enclosing three large leaded lights. The fittings generally are of oak to the architects' design. Especially designed leadwork has been used in the windows of the staircase, court room and all doors having access from the corridors. The heating is on the Webster Modulating System. In the basement of the building are the coroners' room and sheriffs' office, police headquarters and offices in connection therewith, guard room, cell room, janitor's quarters, storage vault and heating chamber. The main floor is occupied by the offices of the government agent, assessors, commissioners, inspectors and records. The second floor is approached by a wide corridor and the main staircase. Situated on this floor are the Supreme Court room and rooms for the judges, barristers, jury and witnesses, as well as the horticultural hall, a spacious apartment measuring 70 x 32 feet.



New courthouse at Vernon, B. C., now nearing completion. Architect: Mr. Thos. Hooper, Vancouver.

A considerable portion of the space on the third floor is taken up with public galleries extending around three sides of the Court Room. The remainder of this floor has been reserved for future use. Altogether the Vernon Court House may well be described as a structure which in its utilitarian qualities and general architectural treatment admirably fulfills the requirements of a public building of this class.

Another outstanding project for which designs have been prepared by the same firm is the proposed wharf and factory buildings for the Royal Crown Soaps, Limited, which will be situated adjoining the Canadian Pacific Railway tracks on Burrard Inlet above the Second Narrows. Plans for the wharf, which will have a frontage of 125 feet and a depth of 160 feet are now in the hands of the Vancouver Harbor Commissioners for approval. In the construction of the wharf reinforced concrete will be used in the form of slotted piles set in the rock bed of the Inlet and tied back to concrete anchor beams placed in the earth fill. Reinforced concrete panels will be placed between the piles with concrete capping all around the water front. Timber fender piles and waylands will also be placed on the outer edge of the wharf, the centre area of which will be covered with a reinforced concrete slab. A subway will lead from the wharf under the Canadian Pacific Railway tracks to the proposed factory building, and plans of this subway have been submitted to the railway company for approval. The length of the subway is about 100 feet, and the interior dimensions are 10 feet wide by 8 feet in height. It has been designed in accordance with the standard set by the Canadian Pacific Railway for subways of this size with floor and walls of concrete and the roof reinforced with heavy steel. Piles will be driven as required under the footings to secure a solid foundation and the subway will be continued on to the wharf for a distance of 80 feet for shipping purposes.

Designs were recently prepared by the firm of Thos. Hooper for two four-room schools which will be erected in the Fraser Valley, at Sardis and Rosedale, for the Chilliwack Municipal School Board. These schools are duplicate structures arranged to permit of future extensions to double their present size. The interior plan of each building comprises a central stairhall with school rooms opening directly from this hall and also accessible through cloak rooms. The second floor contains teachers' rooms and lavatories, while in the basement are the childrens' playrooms, lavatories and heating chamber. The basement is of concrete and frame construction is used for the superstructure, with shingles for the roofing. Each building has ventilating fleche of wood and sheet metal, and is provided with rear fire escape stairs. The walls and ceilings of the interior are plastered and all interior finish consists of B.C. fir. The fittings throughout are all of the most modern description.

A most successful example of the firm's work in the field of residential architectural is a dwelling recently designed for Mr. Geo. E. Winter in which the style is an adaption of half timber work to Colonial requirements. This house is being erected on an attractive site in West Point Grey where on account of a rapid fall to the north an opportunity has presented itself for laying out the grounds in terraces. The main walls of the building will be of frame construction covered with shingles and concrete will be used for the basement walls. Shingles will also be employed for the roofing. The ground floor contains the living room, dining room and breakfast room, the latter opening to a wide verandah overlooking English Bay. The main entrance is on Second Avenue, with the den, lavatory, stairhall, kitchen and serving hall also on the ground floor. On the second floor are situated five bedrooms two having sleeping porches facing the Bay. The main stairway continues up to the attic floor. The basement is occupied in the rear by the laundry and hot water heating apparatus. Fir is used as interior trim, the hall, staircase and main apartments on the ground floor being fitted with panelled wainscotting of this material. Leadwork in the stairway windows and vestibule doors enhances the appearance of the downstairs portion of the interior. The building is equipped with hardwood floors.

The John ver Mehr Engineering Company, Limited, of London, Eng., and Messrs. Wm. Cowlin & Son of Bristol, Eng., as engineers and contractors respectively, have been awarded the contract for the construction of a duplicate mechanical filtration plant at Toronto Island, the amount of their tender being $1,066,283. Both these firms have offices in Toronto. Four other tenders were received for the work, the highest of which was $1,733,463. The accepted tender provides for brick and concrete buildings, with steel filters. The distinctive feature of the filter proposed is the employment of a gradually moving body of sand as the primary or roughing filtration medium, which eliminates as a continuous process the main impurities from the water prior to its passage through the final filtration medium or stationary sand.

The special Commission recently appointed by the Dominion Government to inquire into the commercial feasibility of the Georgian Bay Canal scheme consists of Lieutenant-Col. R. S. Meighen and Mr. Edward Gohier, of Montreal; and Mr. W. Sandford Evans, ex-Mayor of Winnipeg. The Commission will begin work immediately according to an announcement made by Hon. Robert Rogers, Minister of Public Works. Certain sections of the canal may be taken up and reported upon as to their economic feasibility before the issue of a report upon the whole scheme. The two sections mentioned are one from Montreal for some distance eastward, and the section from the French River to Lake Nipissing.

Plans have been prepared by Messrs. Ohrt and Ouistgood, Danish engineers, for a submarine tunnel nine miles long to connect Denmark and Sweden. The estimated cost is about $25,000,000. The tunnel is to be part of a new railway thirty miles long along the coast of the island Amager, south of Copenhagen. The greatest depth at which the tunnel will run will be about 100 feet, and it is estimated that it will take five years to build. The motive power for traction in the tunnel will be electricity. The tube will be driven through the same kind of stratum, gray chalk, as would a tunnel between England and France.

Standard foundation loads adopted by the bridge department of the National Transcontinental Railway, allow 4 to 6 tons per square foot for clay in thick beds, always dry; on clay, moderately dry, 2 to 4 tons; on gravel and coarse sand, well cemented, 8 to 10 tons; on compact, well-cemented sand, 4 to 6 tons; on clean dry sand, 2 to 4 tons. Average pile loads of from 15 to 20 tons each are permitted. Piles are driven to an average penetration of 1 in. in the last few blows of a 2,000-lb. hammer falling 25 ft. This gives a calculated safe bearing load of 25 tons.

The New Provincial Law Courts at Winnipeg

By R. L. Riggs

THE construction of the new Law Courts at Winnipeg is progressing rapidly. The work was started in the spring of 1912 when the contract was awarded by the provincial government to the National Construction Company, Limited. The building stands on the corner of Kennedy Street and Broadway, and forms one of a government group. It is built of natural Manitoba stone, secured at Tyndal, only a few miles from Winnipeg, and has a basement and three storeys. The construction is of steel, with reinforced concrete floors and terra cotta brick partitions.

There are three entrances, the most imposing one facing on Kennedy Street. This is to have handsome equestrian statues on either side. Heavy columns with Ionic capitals and massive pedestals, mark these entrances, one on Broadway and one at the south-east corner. A dome-capped tower over this corner relieves the square uniformity of the building, which otherwise is broken only by its massive entrances.

Entering the building, one is impressed by the high ceilings and spacious corridors, the latter being finished in marble. The various court-rooms, lecture-rooms and consulting-rooms, are large and airy, being well lighted and ventilated.

The library is on the third floor at the rear end of the building. The Assize Court room also occupies considerable space on this floor. A private telephone exchange and also a fire alarm equipment are provided.

A central power-house is under construction for serving the various government buildings in this vicinity with light, heat and water. An underground tunnel will convey these pipes and cables to the different buildings.

The heating system is forced hot water and the radiators are located in recesses in the walls, screened from view. All the risers are concealed. The temperature is under thermostatic control. The mechanical draft ventilating system will be installed, with the necessary washing and purifying apparatus. The fans are all motor-driven, through silent chain drives. A complete vacuum-cleaning system is provided, with plug outlets at convenient points. The lavatories have fixtures of the modern design.

The electric wiring and conduit system will be of the best modern practice. All piping is installed in the concrete floors. Every room in the building is provided with a side wall flush switch, for controlling the lights. The corridor lights are controlled at the distribution cabinets on each floor, and a master set of control switches is placed in the caretaker's suite. The

Manitoba Provincial Law Courts under construction.

fixtures will be of a finish and design to harmonize with the hardware.

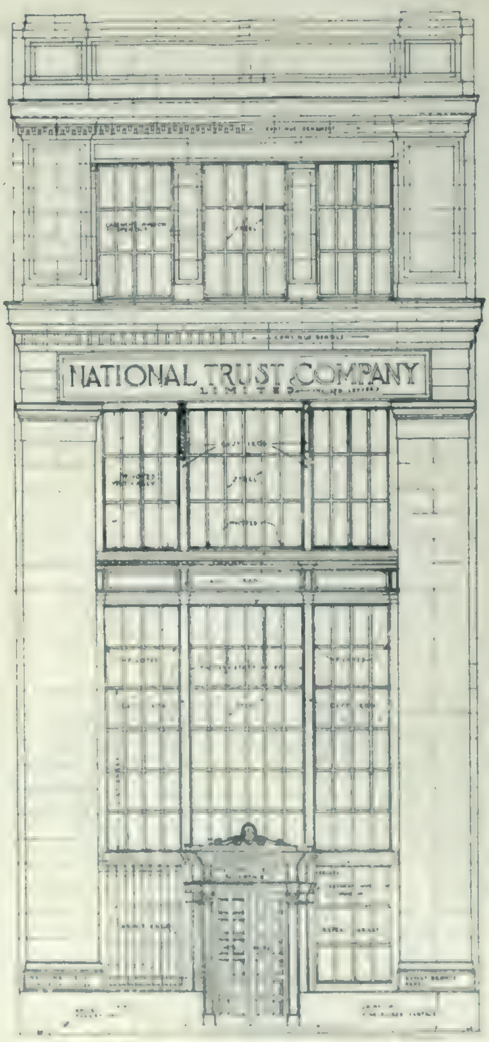
When completed, the new Law Courts at Winnipeg will be one of the handsomest and most modern buildings in Canada.

New Building for National Trust Company, Montreal

Mr. Kenneth G. Rea, F. R. I. B. A., Montreal, has designed a new building for the National Trust Company, Montreal. It will be situated on St. James Street, on a site 21 x 100 ft., and will have foundations and columns of sufficient strength to carry it to the regulation height limit at any future time. The structure will be entirely fireproof, and will have metal windows and wired glass on Fortification Lane. The foundations will be of concrete. The front will be constructed of Argenteuil granite, and the walls wainscotted in Botticello marble to a height of 15 feet, with Caen stone cement plaster above this.

The metal grilles to the elevator enclosures, staircase balustrade, safety deposit vault enclosures, and the office divisions will be bronze plated. The counters and woodwork will be of mahogany. The main entrance from St. James Street will be a very distinctive feature, being intermediate between the basement and main floor, with a handsome marble staircase and balustrade leading up and down. The revolving door enclosure as well as the door itself and the circular sliding doors to shut the building at night, will be of bronze.

The business of the company will be carried on on the main and lower floors, the two upper storeys being rented until required by the company for its own purposes in the future. The safety deposit vaults will be situated in the middle part of the lower floor. There is to be electric lighting and steam heating. The building will be completed and ready for occupation by the first of May, 1915. The contract has been awarded to Messrs. Norcross Bros., Montreal.



National Trust Company's proposed building. Front elevation.

AN APPRECIATION.

A prominent contracting engineer of Western Canada, the author of an article published in a recent issue of the Contract Record, expresses his appreciation of this journal in the following terms:

> "I wish to thank you for the neat manner in which the press work was done and for the attractiveness of the presentation generally. That the article has been read is evidenced by **enquiries received from all parts of Canada** asking where the machinery was obtained and for similar information."

The Contract Record is the recognized medium of the engineering-contracting interests.

H. A. Gardner, of the Institute of Industrial Research, Washington, recommends a pigment of 82 to 88 per cent. of red-lead and the remainder litharge, as being highly inhibitive of corrosion, and more acceptable than any other for general painting purposes. The components should be free from nitrate salts and contain less than 0.5 per cent. of total impurities, such as copper, silica, or iron. The red-lead should be bright in colour, and 99.5 per cent. of a lot should pass a 200-mesh screen. Paints made from this mixture will be practically free from hardening in a package for a considerable length of time, and less expensive than 100 per cent. pure red-lead paints. Excellent results have been obtained in painting directly over metals surfaced with mill scale, especially on large structures; but for smaller work the expense of removing it will be justified by the good results obtained.

The problem of building construction in India is discussed in an American consular report, which states that one of the most significant recent developments in connection with the construction of large buildings in India has been the increasing use of reinforced concrete. This material has greatly increased economy in recent construction of buildings in India, and it is said that it is cooler and more sanitary than native material. Building operations in India have hitherto been noted for undue cost and unwieldy construction. Many houses of the customary type fall every year during the heavy rains at the break of the monsoon, a fact clearly pointing to the desirability of reinforced concrete construction.

The contract for a steel-rivetted pressure pipe line for the Sooke Lake waterworks system has been awarded to the Burrard Engineering Company, Vancouver, by the city council of Victoria, B.C. The contract is worth $324,000.

Three Types of Fireproof Building Construction

By Thos. M. Goodrich[*]

FIREPROOF buildings can be divided into three general types of construction. The first type is the steel frame building, in which structural steel sections are utilized to carry the entire load coming upon them, these sections being fireproofed with concrete or hollow tile. In the floor construction of this type of building reinforced concrete slabs or hollow tile arches may be used. Both of these types of slab construction have given satisfaction. The reinforced concrete slab is most generally recommended because of its greater fire resisting qualities, and because it forms a monolithic fireproofing around the steel frame of the building without any of the joints which occur in hollow tile construction. If the joints of the hollow tile are not absolutely tight there is every likelihood that fire would penetrate through the open joint and serious damage to the structural steel would result. Another point in favor of fireproofing structural steel with concrete is that such construction protects the steel from rust. This type of steel building is the most expensive of the fireproof constructions, but it is used primarily on account of the great speed which may be attained in erection. Because of the excessive cost of same, many owners and architects have been forced to use reinforced concrete, a type of fireproof construction which is much slower to erect than structural steel, usually requiring at least twice the time necessary for the erection of the said structural steel.

Reinforced Concrete Buildings

Another type of fireproof building is that known as reinforced concrete. In this type of construction, beams, girders, columns and slabs are formed of concrete reinforced with various types of patented, deformed bars, cold twisted square rods, or plain round or square rods. It is necessary that a substantial frame be built of wood or metal to contain and support the reinforced concrete columns, girders, beams and slabs until such time as they are so thoroughly set, or hardened, that it is safe to remove the frame structure or forms, as this is generally called. This necessitates a slower process of construction than can be obtained by using a steel frame structure. In reinforced concrete, the columns are of two types, viz., columns reinforced with longitudinal rods tied together at intervals with wire, and columns reinforced with longitudinal rods and spirals, the longitudinal rods being wired to the spirals. The beams are reinforced with rods which act in tension only, and the strength in compression is developed by the concrete above the neutral axis of the beams. Slabs are reinforced concrete, utilizing various types of reinforcement. There are also several types of flat slab construction in which no beams or girders are ordinarily used. In this type of construction it is usually necessary that columns have caps, which are required to give additional support to the slab. Additional steel is placed within these caps extending into the column and radiating from the column into the slabs. There are various arguments favoring the use of reinforced concrete construction, chief of which is that it is considerably cheaper than structural steel construction. One argument against its use is that speed of erection is very much slower than structural steel. Another is that in high buildings, or in low buildings having heavy live floor loads, columns must be built of such great size that too much valuable floor space is wasted.

The System "M" Type

The third type of fireproof construction is that which is known as System "M." This construction is patented by Mr. Guy B. Waite, Consulting Engineer, New York City. System "M" structural steel is used in a manner more economical than that of the ordinary type of steel construction mentioned in the first part of this article. System "M" columns are of several types. Where it is desirable to make them as small as possible, "H" shape or plate and angle columns are used to carry the entire live and dead loads coming on them. Columns erected in this manner can be fireproofed with concrete, hollow tile or other fireproof material. Another type of column used is formed of two channels turned towards each other, these channels being connected with batten plates or lattice bars. These columns, after being erected, are filled with concrete and the same takes its part of the load in conjunction with the structural steel. Another type of column used in System "M" construction is formed of four angles turned toward each other, connected together with batten plates or lattice bars and filled with concrete as mentioned above. Beams and girders used in this construction are a combination of structural steel and concrete, the strength in tension being developed by small steel "I" beams, channels or other structural shapes. These are placed below the neutral axis of the combined concrete and steel beam. The strength in compression is developed by the concrete above the neutral axis of the combined concrete and steel beam. Slabs between beams and girders are of reinforced concrete and various types of bar or mesh reinforcement may be utilized in same. With buildings of System "M" construction the same speed (and often better) can be made in erection as is obtained with the ordinary steel frame type of construction mentioned in the first part of this article. This is possible because less shop work is required in System "M" construction, and there is considerably less tonnage to handle in the field. System "M" buildings twenty storeys high have been erected. In high buildings erected in this type it is possible to make any needed provision for wind bracing. Steel may be erected several storeys ahead of the forms and concrete, the forms being suspended from the structural members. The webs of beams and girders are punched to receive shear bars, which pass through the webs and extend into the slabs. By this means a rigid shear bar connection is obtained with the tension member, which is not the case in the majority of buildings classified under the second part of this article. It is impossible to misplace the structural members of System "M" work, as detailed drawings are made for the various members in the same manner as is required in the ordinary type of steel frame buildings. The connections of the various members to each other are made in the same manner as in the ordinary type of steel frame building mentioned in the first part of this article. As regards the economy of System "M" construction over the usual type of steel frame building, the saving is from 50 per cent to 70 per cent of the tonnage required for beams and girders. If the columns are built of two channels or four angles, a considerable saving is made in the amount of steel entering into the columns. In numerous cases System "M" has competed against reinforced concrete and secured the work on a competitive basis. A building in this type of construction can be built in considerably less time than in reinforced concrete and gives the owner a much better type of fireproof building.

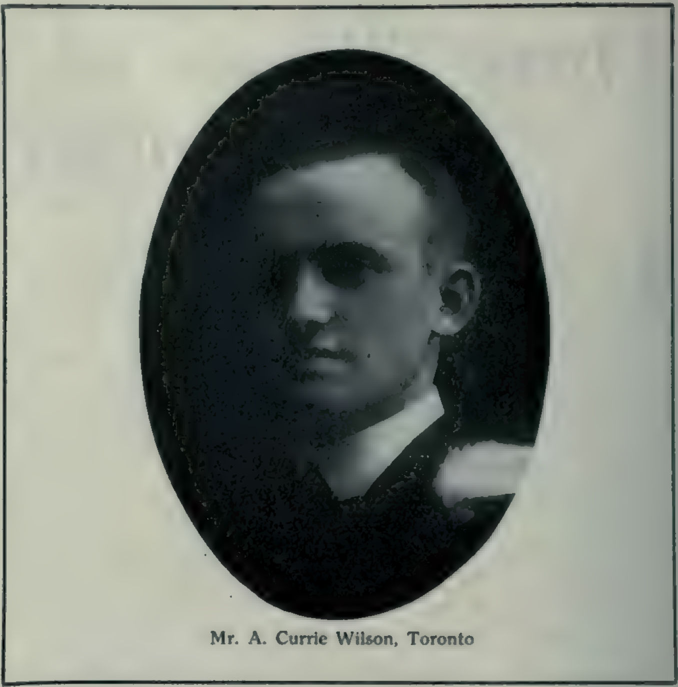
---

[*] Chief Engineer, Canadian Standard Concrete Steel Company, Winnipeg.

Prize Design for Hydraulic Power Station

We reproduce herewith a design submitted by Mr. A. Currie Wilson and awarded first prize in the competition for architectural students of the University of Toronto, in connection with a hydraulic power station on the Cascade River, near Banff, Alta., in the Rocky Mountain Park. The prizes were offered by Mr. C. H. Mitchell, C.E., Consulting Engineer to the Dominion Water Power Branch.

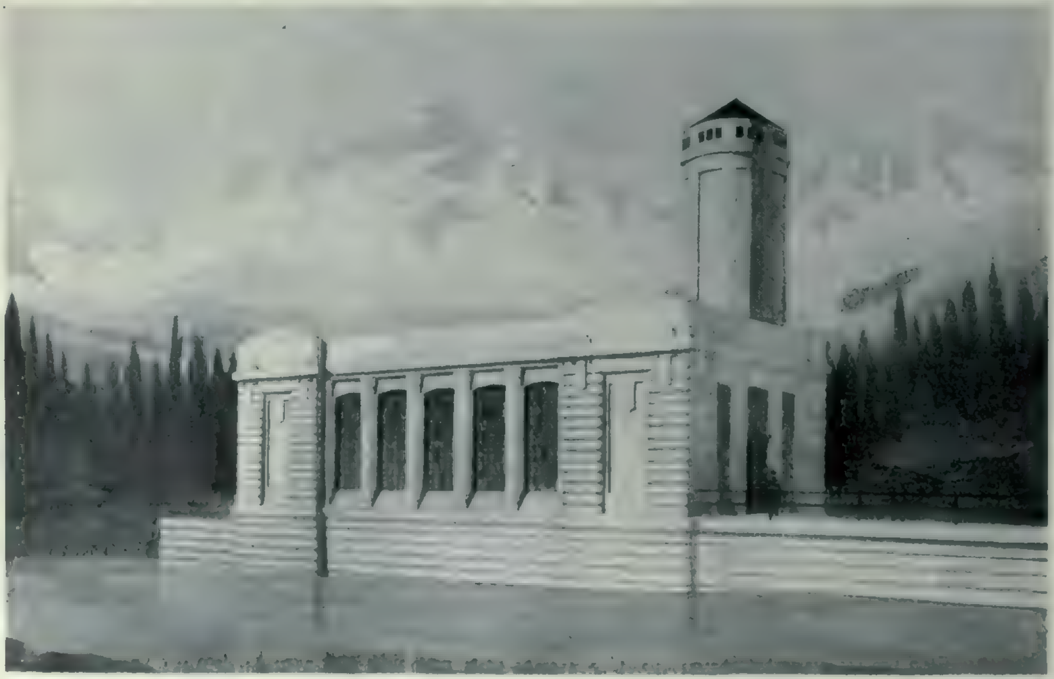
It is understood that the Government will adopt Mr. Wilson's design in the construction of the new building, the dimensions of which will be about 38 ft. by 80 ft. The structure will be built of reinforced concrete or stone. There will be three complete units on 18 ft. centres. Water power is derived from Lake Minnewanka above the site of the proposed power house. By damming the lake at this point the required level is attained. The water is then led through a rock tunnel 600 ft. long to a wooden stave flume line, about 1,800 ft. long, and thence to the water tower shown in the illustration. This tower will take charge of surplus water in the event of the shutting off of the turbine.



Mr. A. Currie Wilson, Toronto

Mr. Wilson is a native of Toronto and entered the Department of Architecture of the University of Toronto with Class '14 in 1910. He has had considerable experience as a draughtsman with architectural and engineering firms and intends to specialize in architectural design.

The ice-breaking car ferry steam-boat, now under construction at Birkenhead, Eng., for the transportation of N. T. R. trains across the St. Lawrence, pending the completion of the Quebec bridge, will be delivered at Quebec in May or June. The principal di-



Prize design for hydraulic power station, near Banff, Alta.

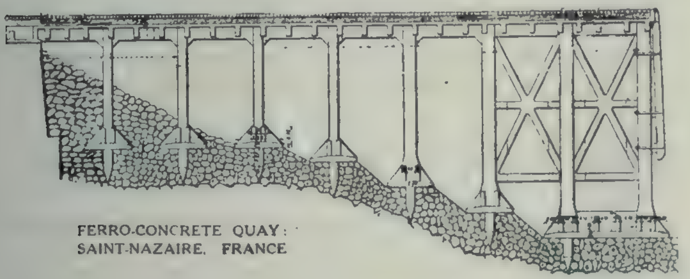
mensions of the ferry are: length, over all, 326 ft.; beam, 55 ft.; with a mean draught of about 55 ft. The propelling machinery will consist of two sets of triple expansion condensing engines, steam being supplied by 8 single-ended, cylindrical boilers working under actual draught. An ice-breaking propeller will be fitted at the forward end driven by a compound condensing engine. The vessel is designed for the conveyance of passenger and freight trains at all seasons. The trains will be carried on a tidal deck arranged above the main deck columns, the latter being stayed by lattice buttresses against longitudinal and transverse trusses.

Novel Type of Foundations

EVERY civil engineer worthy of the name must be able to recall numerous instances of invention begotten by sheer necessity. A case in point is furnished by the recent extension of the quays in the French port of Saint Nazaire.

After the Port Authorities had made an unsuccessful attempt to construct foundations for the extension in the soft mud of the harbour, the problem was submitted for solution to M. Hennebique, of Paris. Owing to the extremely low bearing power of the soil, the foundations were formed of ferro-concrete piles having an extended footing a short distance above the point so as to distribute the load.

As shown by the drawing, the footings rest upon platforms constructed of rock and rough concrete. The footings were first adjusted in position by divers, and the ferro-concrete piles were then driven through a square hole moulded at the centre of each footing. The piles take a secure bearing upon the footings and effectually prevent any transverse movement of the latter. The piles were grouted into the footings after having been driven, thereby rendering the whole perfectly monolithic.


FERRO-CONCRETE QUAY: SAINT-NAZAIRE, FRANCE

In order to render the structure additionally secure the front rows of footings were connected by horizontal beams and the front rows of piles by horizontal and diagonal bracing as shown by the drawing. The works were completed several months ago and have given every satisfaction to the Port Authorities.

The quay extension is 1,272 ft. long, and the entire structure was carefully tested after completion under the uniformly distributed superload of 4 metric tons per square metre.—Ferro-Concrete.

A project is before the St. Petersburg Town Council for the establishment of a municipal brickworks to produce at the beginning about 10,000,000 bricks a year, the production to be increased as required by the erection of fresh works in convenient parts of the town. A similar scheme is on foot for the town of Kieff, to produce 5,000,000 bricks a year, the cost of the works to be about 160,000 roubles ($85,000).

LETTERS

The Cause of Several Dam Failures

Editor Contract Record:

I note in your issue of April 15 an article concerning the possible cause of failure of dams. The writer believes this to be a very important paper and is pretty strong in the opinion that several of the most notable dam failures in the country have been due to rock sliding on itself by reason of clay seams in the natural horizontal stratification, where the designer, assuming the bearing power of the rock to be perfectly safe, failed to go down a sufficient depth to provide a barrier, or bulkhead, against the downstream toe which would prevent sliding.

This is discussed fully in a paper by the writer presented to the Engineers' Club of Philadelphia and published in their Proceedings of January 1st, 1912.

It is quite likely that this was the cause of the failure of the dam at Austin, Texas, although that was not given as the theory in the discussion by engineers at that time, but that dam certainly failed by sliding, and the coefficient of friction of the masonry on the rock with the irregularities of the surface would hardly be low enough to account for the failure. Upward pressure can readily be eliminated by making the connection between the base of the dam and the rock previous to water by drainage, only providing a water-tight section under the upstream toe, as outlined in the writer's paper above referred to.

Yours truly,

J. W. Ledoux.

Personal Mention

Mr. Thomas Allison, Toronto, has been appointed Road Superintendent for Wentworth at a salary of $1,800 a year. He was formerly road foreman at Galt.

Mr. Morris Foster, who is well known in building and contracting circles in Toronto, died on April 18 in his seventy-eighth year, following an attack of pneumonia.

Mr. Alexander Watson, Sr., who for almost forty years was in the foundry business in Woodstock, passed away in Toronto a few days ago in his eighty-fourth year.

Mr. F. G. Adams, division freight agent of the Grand Trunk Pacific at Edmonton, has been selected to fill the position at Winnipeg, rendered vacant by the death of Mr. W. J. Hunter.

Mr. F. W. Cowie, Chief Engineer of the Montreal Harbor Board, has been awarded the Telford Gold Medal of the Institute of Civil Engineers, for his paper, "Transportation Problems in Canada, and the Montreal Harbor," read on April 7, 1914. Mr. Cowie's paper was an elaborate review of the history of navigation on the St. Lawrence and the Great Lakes.

Sir William Whyte, who was formerly a Vice-President of the Canadian Pacific Railway, died on April 14 at the Hotel Del Coronado, Coronado Beach, Cal. Sir William had resided in Western Canada for more than a quarter of a century, during which period he was in the service of the Canadian Pacific Railway, coming to Winnipeg as General Manager. Eventually he became Vice-President in charge of the western lines and finally western director. He was born on September 15, 1843, at Charleston, Fifeshire, Scotland.

Technical and Economical Aspects of Road-Building in Quebec*

By Gabriel Henry†

(Conclusion)

The Question of Surfacing

There is a great variety of surfacings. Leaving aside the earth, sand, clay and ordinary gravel roads which are, as previously stated, very convenient in the majority of the rural roads where the traffic is only local and light, the principal surfacings for highways and rural roads are:—Waterbound macadam and waterbound gravel macadam; bituminous macadam, penetration method; bituminous concrete macadam, mixing method; tar macadam, penetration method; concrete tar macadam; cement concrete surfacing, penetration method (Hassam process); cement concrete surfacing, mixing method.

This is a rough classification. Many attempts have been made elsewhere to properly classify and name the road surfacings, but a complete understanding has not yet been arrived at. Of course, the composition of aggregate used with bituminous or tar cement, for instance, in the mixing and penetration methods, varies greatly and sometimes there is little difference between the aggregate used in the two methods. The names of the surfacing are very numerous, depending on some process in the execution of the work and on the nature of the cement and aggregate used.

Apart from the above surfacing some chemical products, such as rocmac, are found on the market, the function of these being to bind or help to bind stone in the macadam.

Tar, bitumen oils and other chemical or residual products such as calcium chloride and glutin should also be mentioned. Their functions are to protect the road surfacings against the wheels of vehicles, to give them a longer life and to lay dust. These preventives have to be renewed more or less frequently.

The author is merely speaking here of the surfacing and preventives generally used in rural road and highway work and not of the still more expensive paving used in cities.

Now what is to be said in regard to all the above named surfacings? There are such great and important interests concerned in bitumen, tar and cement surfacings, success and failure are in fact so mixed up and the experiments, as reported, have given such widely varying results, that it would be very difficult to give a categorical opinion.

With the economical aspect of the question in view the following conclusions can be drawn:—

There is not at present any surfacing good for general purposes. Automobile traffic requires certain qualities for surfacing, and the narrow steel tires, heavily loaded waggons and motor trucks need others.

All kinds of surfacing can be used with advantage if judiciously and suitably chosen, well laid and maintained.

All surfacings require to be maintained with the greatest care.

A combination of steel tire and of soft tire traffic in different proportions require in each case specially appropriate surfacing.

Bituminous macadam and bituminous concrete macadam, as well as tar, are very suitable for automobile traffic.

Experiments on concrete roads point towards a more general use of concrete surfacing, which does not seem to be affected by a cold climate.

Waterbound macadam, well built, is good for rural roads where automobile traffic is not heavy. Tarring and oiling lengthen its life and allow a medium heavy automobile traffic on it.

All that has been said above presumes that the substructure of the road has been sufficiently drained, that a substantial foundation has been provided for, and that the sum of the thickness of the foundation and of the surfacing are in keeping with the nature and the dryness of the substructure The road is also supposed to be maintained with care.

In choosing a surfacing the following should be taken into account:—1st, the nature and importance of the traffic both present and future; 2nd, the first cost of the surfacing; 3rd, the probable life of the surfacing; 4th, the cost of its maintenance.

Such information is now easily obtained, and by adding in each case the interest on the first cost, the annual annuity for depreciation fund and the probable annual cost of maintenance of two or more surfacings, the total will indicate the one to be chosen. The first cost should be established as first class.

It may be added here that bituminous and tar surfacing require very great care and experience to be laid properly and that it is more difficult to lay them in this country in a dry climate.

The annual period of work in the Province of Quebec is about one hundred working days; rainy days are frequent as well as variations of temperature, which are at the same time very great.

For a good bituminous and tar surfacing the stone must be dry and not very cold when cement is added. The degree at which the bitumen or tar is to be heated depends to a certain extent on the temperature of the stone and of the atmosphere, and in the autumn the weather is often wet and cold.

With waterbound macadam, as well as other pavings and especially concrete paving, the quality of the stone plays an important role. Soft stone should be avoided as much as possible.

In the Province of Quebec trap and good rock for road purposes are scarce. Field stones are generally employed and the quality varies greatly as they are generally mixed with bad stones. Sandstone of inferior quality is very common; in some districts a kind of bad granite is found, while gravel and quarries with good material for road purposes are rare.

For waterbound macadam, the author advocates the two course macadam:—bottom course, 4 inches loose stones of 2½ inches ring, well rolled with a steam roller of at least 10 tons, no filler; top course, 4 inches loose stones of 2½ inches ring, and appropriate binder entered dry in the course with broom and roller in as great a quantity as possible. The first layer of the binder should be applied before the rolling is begun, and when it is not possible to enter more binder without the roller spraying is resorted to.

The road should be sprinkled until saturated, the sprinkler being followed by the roller. More screenings must be added if needed, and the sweeping, sprinkling and rolling continued until a grout has been formed of the screenings, stone dust and water to fill all voids and form a wave before the wheels of the roller. After that, enough screenings should be spread over the macadam to leave a wearing surface at least three-eighths of an inch thick.

With limestone a course-grained sand, as well as the dust of the crusher, is good, but with granite a limestone binder is generally required. In some districts of the Province only sandstone is available. A limestone binder would be suitable with these stones, but, unfortunately, in these districts no limestone is found, and in such cases the dust from the crusher or the sand is of no value and it is impossible to bind the macadam. Thus the only way to obtain a first bond is to use clay and the traffic does the rest, but for two or three years it is necessary to keep the ruts filled with surface even. Experience shows that it is possible to obtain good results in this way.

---

*Paper delivered before The Canadian Society of Civil Engineers in Montreal on April 9.

†Chief Engineer of the Department of Highways for Quebec.

The crown of the macadam is generally three-quarters of an inch for a 16-foot wide surfacing; for a bituminous or tar surfacing half an inch is enough; for concrete one-eight of an inch is suitable.

The choice of a macadam as a surfacing depends not only upon the nature and the importance of the traffic, but also on the quality and the price of the stone. When the stone is of bad quality and dear, it is often more economical to use a more expensive surfacing. In the opinion of the author, the best macadam would be of one sized stone 2½ inches ring, with an ordinary soil, a total thickness of about 9 inches comprising the foundation; also macadam stone should not be mixed with an undue quantity of smaller stones or sand. For a wearing course such a mixture containing too great a proportion of small sized stones and of screenings is not suitable. As a rule it is not uniform, the larger and smaller sizes have a tendency to separate and, if not mixed with care and laid with shovels, the resulting macadam will have a very irregular wearing quality, and ruts and depressions will consequently follow.

In this Province it is very difficult to obtain the one sized stone at a suitable price because few regular quarries sell macadam stone. It is necessary to use transportable crushers, but these give many flat chips which must be utilized. Meanwhile, everything should be done in order to obtain the standard cubical uniformly sized stone.

The preventives mentioned above are serviceable in many cases, but their cost compared with results is rather high and generally have to be applied at least every year. Tarring, however, has given very good results.

The question of the width of the surfacings is not yet completely settled. Meanwhile experience shows that a width of 16 feet is suitable for a provincial road and for less important roads 14 feet is convenient. Shoulders should have a width of at least 4 feet.

Apportioning Work and Costs

Next comes the question of who shall pay for the improvement and the maintenance of roads. Until five or six years ago, in the English townships of this Province, the roads were in charge of the municipalities and were maintained by "statute labor." In the French municipalities the system of shares was almost general.

These two systems were instituted by the settlers in the early days of the colony. Of course, in a vast country, with settlers far distant from one another, it was very difficult to maintain the roads, and each settler took care of his own. In remote colonization districts these systems are still to a certain point rational. They have been transmitted to this generation without any marked modification, have been recognized and regularized by the Municipal Code, and the farmers are still so accustomed to them that it is very difficult to make a change. However, the population and the traffic are growing so quickly that the maintenance of roads is now becoming very difficult and costly, and the old systems no longer meet the situation.

In the States many years ago, statute labor was improved by the collection of taxes instead of work by the municipalities; later, the system of county roads, a far more rational one, was introduced and is now general.

In this Province no county has yet taken charge of its roads, and those called county roads by the Municipal Code are in the charge of the municipalities and are maintained by "shares" or by "statute labor" like by-roads.

Five years ago the Provincial Government passed an Act with the intention of inducing municipalities to abolish "statute labor" and the "shares system," to take care of their own roads, to collect taxes for this purpose and to put the improvement and maintenance of roads under the supervision of a limited number of overseers chosen by the Municipal Council. It is only fair to say that the municipal income is generally trifling, while the mileage of the roads is great, many municipalities having more than 100 miles of bad roads to improve and maintain.

However, since the passing of the Good Roads Act relating to maintenance, some four hundred municipalities, out of eleven hundred in the Province of Quebec, have followed the movement, abolished their "statute labor" or the "shares system" and taken the roads under their charge. Many of the others still cling desparately to the old system in spite of the efforts made by the Government to induce them to abolish it.

A new generation, more favourable to the change, is growing up, and as traffic is increasing at the same time it is to be hoped that in a few years the old system will be a thing of the past. At present the principal object is to direct the movement wisely and prevent extravagances. If this is done and the county road system is then introduced, an economical and effective system will be organized for the improvement and maintenance of rural roads by the municipalities and counties suitable for many years to come.

The advent of automobiles, although an important factor in the question of roads, does not particularly affect the rural roads because automobiles will not for some years increase in such number in rural districts as to cause apprehension to the farmers on account of additional expense in maintenance. It only affects such roads in the sense that automobilists ask for better rural roads; while the difficulty lies in the fact that they desire many highways crossing the country which the farmers contend are not necessary to them and which they will not maintain. Who then is to pay? The improvement of rural roads will benefit the whole country, as well as the farmers, the municipalities and the automobilists. The provincial highways will also benefit the country, the farmers and the automobilists. It thus seem justifiable to divide the cost of improvement and maintenance of the roads of the Province between the three interested parties.

What is to be the proportion for each of them? This is a very intricate question, but one which can be solved. For speedy work, money is not at hand here as elsewhere. The system of long-term bonds in the United States came first on the assumption that the next generation would benefit by the improvement as well as the present one. But complaints soon arose. One thing had been overlooked, and that was the difference between permanent work and passing or short lived work.

For permanent work long term bonds can be used. Short lived work constitutes the larger proportion of surfacing. A good bituminous surfacing is said to last from 10 to 15 years with a moderately high traffic in spite of the maintenance. Consequently, for such surfacing only ten year bonds would be advisable. For this kind of surfacing, which on account of its high first cost is chiefly used on highways with an important traffic, long term bonds should be avoided because, in spite of maintenance, long stretches have to be renewed at the same time. A macadam well maintained and without automobile traffic will last a long time, as has been proved by many examples in the old countries, provided the maintenance is complete and effective, the material for macadam being generally at hand and good road men being found easily along the road and put in charge of the work. In such cases longer bonds are to a certain extent reasonable.

The fact should not be overlooked that in this country the roads are covered by snow for a great part of the year and, consequently, surfacings last far longer than in southern countries.

In this paper the author has only spoken of the details of construction, more particularly connected with roads and of the more neglected ones, leaving aside those forming part of common engineering practice. Owing to the fact that the question of roads is very intricate and its economical aspect important, it has been deemed more advisable to lay stress chiefly upon the general facts governing this question inasmuch as the road engineer has continually to deal with these in practice.

The attention of engineers the world over is being directed to the programme of the International Congress, which is to be held in San Francisco in 1915. Considerable interest in this meeting has been aroused, as shown by the fact that at the present time enrolments and subscriptions have been received from forty-two countries. Full information concerning the Congress may be obtained on application to the Secretary, Mr. E. J. Dupuy, to whom communications should be addressed at the Foxcroft Building, San Francisco.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The Corbett Contracting Company, Limited, Welland, Ont., have been incorporated with a capital of $100,000. The new company will undertake general contracting.

Mr. Michael Conroy, a St. Catharines contractor, has secured the contract involving 800,000 cubic yards of team work on the new Welland ship canal near St. Catharines, Ont.

It is stated that many residents of Peterborough and Otonabee have protested against the proposal of the City Council to build a sewage disposal plant at the east end of the river.

The Toronto Works Commissioners have been asked by the Board of Control to make a report upon the advisability of increasing the amount of contractors' deposits on tenders for city works.

At Fort William, Ont., operations have been renewed on the Customs House, a three-storey building of reinforced concrete and steel construction, with brick and tile facing, estimated to cost $175,000.

While a bridge gang was engaged tearing down a temporary trestle at English River on the N. T. R. west of Cochrane, Ont., the foreman, Jose Sunstoun, was struck on the head by a falling timber and killed.

The present season will probably see several miles of new pavement laid in Ottawa. The Ottawa Construction Company will shortly start work on the construction of 25,000 sq. yds. of asphalt, at a cost of $61,120. It is also proposed to lay one and a half miles of additional pavement.

The improved programme of construction work for this season has been prepared by the town engineer and submitted to the city council of Outremont, Que. The work, which will cost about $300,000 comprises the installation of a new street lighting system, new sewers, paving and opening of roads.

The registration of all master plumbers under the control of the Medical Health Department has been suggested to the Toronto Board of Health by the licensed plumbers of the domestic, sanitary and heating engineers of Toronto. They also suggest the raising of the license fee from one dollar to $25.00 a year.

A delegation of about one thousand representative Canadians approached the Dominion Government recently on the subject of the proposed Georgian Bay canal scheme. A permanent organization meeting was held in the city hall, and it was decided to furnish all necessary information to the recently appointed Government Commission.

A contract has been awarded by the city of Windsor to the William Hamilton Company, Peterborough, for the supply of all the ornamental standards required for the new street lighting system to be installed in the business section of the city of Windsor. There will be approximately 300 of these standards, each equipped with magnetite arc lamps.

According to present indications the amount of building to be carried out in Toronto this season will eclipse that of any previous year. The total value of permits issued in 1912 was approximately twenty-seven and one-half millions, which constituted a record. This year Mr. Price, Acting City Architect, is of opinion that the total amount will be well over twenty-eight millions.

Artesian wells, which promise to solve the problem of supplying the town of Steelton, Ont., with pure water, have been discovered by an Italian named Augusto Biagini, in the western portion of the town. Two-and-a-half-inch pipes have been sunk to a depth of 78 feet, and are now supplying 350 gallons of water a minute. The town will likely erect a pumping station and standpipe to control the supply.

At Quebec on April 11 the Hon. L. P. Pelletier, Postmaster-General, replying to a delegation of Quebec and Levis citizens who waited on him regarding the establishment of a branch of the Armstrong firm at Lauzon, where a new dry dock is to be constructed, stated that the Government fully recognized the importance of encouraging the shipbuilding industry, and that all Government vessels would in future be built in Canada.

The plans for Toronto Union Station, which it is estimated will cost between twelve and fifteen million dollars to construct, have now been decided on by the Grand Trunk and C. P. R., and will be laid before the Railway Board about May 15, upon approval of which work will proceed immediately. The new station will occupy the entire Esplanade from Yonge Street to Bay Street, with elevated tracks running east and west.

Mr. L. C. Fritch, the newly appointed assistant to the president of the Canadian Northern Railway, was in Montreal inspecting the Canadian Northern terminals, and left for Quebec on a tour of inspection of the C. N. R. eastern terminals. Mr. Fritch is a well known expert on terminals, and did much work in that line with the Illinois Central and Chicago

& Great Western Railways. He was Chief Engineer of the latter road before joining the Canadian Northern at the beginning of April.

The Allan Line has decided to make Quebec a terminus for two of their latest liners pending the deepening of the St. Lawrence between Quebec and Montreal. The necessity for a deeper channel has been strongly advocated, and in view of this the Department of Marine and Fisheries have issued returns showing that from 1851 to the close of the fiscal year 1912-1913, $9,610,260 was expended in dredging and over $6,000,000 in plant, shops and surveys. The number of cu. yds. dredged amounts to 85,160,875.

The Ottawa Water bill finally passed the Dominion Parliament on April 17. While the principle of the Currie-McVeity scheme is retained the measure sanctions any change in the location of the intake pipe, filter beds, reservoir, etc., that the experts may deem desirable, and provides for an increase in the cost of the scheme to the extent of $2,000,000, if necessary. A clause in the bill provides for the city obtaining the supply from Thirty-One Mile Lake in the event of the Board of Health disapproving of the Ottawa River plans.

Sixty-three sets of drawings for the new Government departmental block at Ottawa have been submitted by architects throughout the British Empire. The assessors, Messrs. T. E. Calcutt of London, J. H. G. Russell of Winnipeg, and J. O. Marchand, Montreal, have selected the six which in their opinion are the best. The names of the authors are not known, the plans having been dealt with so far only by numbers. Without divulging the names the Department of Public Works will request the designers of the six sets of plans to submit complete working details by September 1. The first choice of the assessors will then be commissioned to prepare working drawings, upon which tenders will be invited, and to supervise the carrying out of the work at a commission of 5 per cent. of the contract price. Each of the five unsuccessful final competitors will be paid $3,000 for his work in elaborating the preliminary design.

WESTERN CANADA

At Calgary, Alta., the ratepayers have approved bylaws to expend $260,000 on pavements and $233,000 on concrete sidewalks, curbs and gutters.

At Weyburn, Sask., a bylaw is to be submitted on May 5 to raise $105,000 for extensions to the sewers and water mains. The Engineer in charge is Mr. Geo. Reed.

Tenders are about to be called for the building of a new church for the parish of St. Barnabas at Victoria, B.C. The architect is Mr. J. Drummond Beatson, of the firm of Jones & Beatson, Victoria.

The Manitoba Gravel & Sand Company, Limited, has been incorporated with a capital stock of $100,000 to carry on a general retail and wholesale gravel and sand business. The headquarters of the company are at Winnipeg.

The Pacific Dredging Company, Vancouver, B.C., have been awarded the contract for harbor improvements at Vancouver, estimated to cost $756,000. The work includes a jetty wall, 22,300 ft. long, and a channel 300 ft. wide at the mouth of the Fraser River.

Office headquarters of the International Irrigation Congress, which will meet for the first time in Canada next September, have been opened in the Board of Trade Building, Calgary, where the Congress will be held. The secretary is Mr. Arthur Hooper, who is doing everything in his power to make thes forthcoming event a success.

Bylaws recently approved by the ratepayers of Regina, Sask., authorize the expenditure of $1,441,000, of which practically two-thirds will be for extension of public utilities including sewage disposal works, generation and distribution of electric energy, storm sewers, street railway and water-works extensions, and the addition of a new wing to the local hospital.

The Works Committee of Fort William City Council have outlined in detail an elaborate programme of street improvements for this season. If their recommendations are sustained by the council, the work will be started almost at once, and will cost in the neighborhood of half a million dollars, to include extensions to paving on some of the principal streets; macadamizing on others, and gravelling the less important ones.

Plans for construction work to be carried out by the Saskatchewan Highways Commission this season were recently before the Commission for consideration. An expenditure of $1,500,000 will be made on roads and bridges. The largest undertaking in regard to the latter is the completion of the high level bridge at Saskatoon, which the Department anticipates will be finished by December 31st of this year. Approximately $100,000 will be expended on small concrete and steel bridges.

The C. P. R. Company are improving their hotel accommodation in many parts of the west. At two of the company's most popular mountain resorts, Banff and Lake Louise, the buildings are being increased to provide four hundred rooms. The big hotel project in hand at Vancouver will provide a building containing seven hundred rooms. It will be sixteen storeys in height, while the roof will be laid out as a garden. The building alone will cost about $2,000,000.

The new building which is in course of erection at Winnipeg for the amalgamated firms of Henry Birks & Sons and the Porte & Markle Jewellery Company, promises to be one of the finest structures in Western Canada. With a frontage of 90 ft. on Portage Avenue and 130 ft. on Smith Street, the building is after style of the Italian Renaissance. Beneath the overhanging cornice is a bronze frieze representing the Queen of Sheba bringing fine gold and precious stones to King Solomon.

The City Council of Victoria, B.C., is taking steps to secure data from cities where bridges of the Bascule type have been built, with a view to the construction of a similar structure in that city. Work on the preparation of preliminary plans and estimates of cost will be commenced at once, this work to be done by Government engineers, the letting of the contracts to be carried out by the city under the supervision of the Government. According to original plans the bridge should be erected by the Government and handed over to the city, but by a new arrangement the task will be carried out by the city, and the Government will retain supervision of the work.

The Victoria, B.C., City Council has approved of the terms of the contract between the city and the Burrard Engineering Company of Vancouver, for the fabrication and laying of the steel rivetted pipe line between Humpback reservoir and the city. The contract will be finally ratified as soon as the company provides the bond guaranteeing completion of the work in accordance with specification. The contract calls for the manufacture of the pipe in the vicinity of Victoria at the rate of 250 lineal feet a day. In the opinion of Mr. Rust, Water Commissioner, the firm should complete the contract in nine months upon the basis of 250 lineal feet a day.

Sir John Wolfe Barry's plans for the proposed bridge across the Second Narrows, Vancouver, are said to be regarded as too expensive by the directors of the Burrard Inlet Tunnel & Bridge Company. It is officially announced that Alderman Woodside and Mr. Ernest Cleveland, of Messrs. Cleveland & Cameron, the local engineers who are associated with the British firm, will proceed to England to take up the question of reducing the original specifications in order to effect a substantial saving in the cost of the structure. The board will probably find it necessary to invite fresh tenders for the construction of the bridge, as the lowest combined bid, covering both substructure and superstructure in compliance with the British engineers' plans, figured out at $2,376,531.

Canadian Railroad Development

From an official announcement made a few days ago it would appear that the Lake Erie & Northern Railway will not be in actual operation until towards the end of 1914. The ballasting on the road between Brantford and Galt will not be completed for a couple of months. Work on the Waterford bridge is nearing completion, but the Brantford bridge has yet to be constructed.

The Intercolonial Railway Company are having a survey made by their engineers with the object of collecting the necessary data to divert a section of the road so as to overcome the heavy grade that exists between Amherst and Nappan, N.S. The proposed diversion would probably begin at a point west of Amherst and strike the main line of the Intercolonial near Blair's Lake.

Mr. F. H. Clergue, President of the North Railway Company, which anticipates putting under contract the construction of a branch line from Montreal to join the Transcontinental road, has in hand a project for opening up the territory tributary to the railway as proposed between Montreal and Ottawa, on the James Bay. Mr. Clergue expects that the first section uniting Montreal with the Transcontinental Railway will be completed in about two years.

Sixty steel and wood bridges, ranging from 75 to 125 feet in length, will be required in a distance of eighteen miles on the Central Canada Railway, north of Edmonton, for which the route plans have just been filed with the provincial department of railways for Alberta. The survey shows a road from the main line of the Edmonton, Dunvegan and British Columbia Railway at Round Lake, along the North Hart River to the Peace River Crossing. Numerous other engineering difficulties are presented. Engineers report that at least 50,000 yards of earth will have to be removed from every mile of line on the right of way along the North Hart River. The cost is placed at 50 cents a yard. It is estimated that the construction cost of this stretch of line will be more than $50,000 a mile, or $30,000 a mile more than the bonded obligations of the provincial government. The sliding banks along the tortuous windings of the North Hart River are fully 700 feet above the high water level. The grade drops that distance in the eighteen miles of line before reaching Peace River Crossing, where the railway company will span the Peace River with a steel bridge, costing $400,000. Thence the line will continue to Dunvegan, along the north bank of the Upper Peace River. The Central Canada Railway, upon which it is officially announced, work will begin this season, is to be the connecting line between the Edmonton, Dunvegan and British Columbia, and the Pacific Great Eastern railways.

City Planning Conference at Toronto

An International Conference on City Planning is to be held in Toronto, May 25-27. This will be the first occasion on which a Canadian city has been chosen for such an event and the meeting is looked forward to with much anticipation. H.R.H. the Duke of Connaught, has graciously consented to open the Conference and to give an address.

The scope of the Conference may be guaged by a glance at some of the topics which will form the main themes of discussion. Among these may be cited: The Relative Importance of City Planning as Compared with All Other Functions of City Government, by Andrew Wright Crawford, Editor of the City-Planning Section of the "Public Ledger"; Provision for Future Rapid Transit, by J. V. Davies, Consulting Engineer for the Brooklyn Rapid Transit Company; Rapid Transit and the Auto Bus, by John A. McCollum, Assistant Engineer, Board of Estimate and Apportionment, New York City; Protecting Residential Districts, by Lawrence Veiller, Secretary and Director of the National Housing Association, New York City; A Consideration of the Principles and Procedure of a Canadian Town-Planning Act, a draft of which is now being prepared by a special committee appointed by the Commission of Conservation; and Recreation Facilities in the City Plan, by Henry V. Hubbard, Professor of Landscape Architecture in Harvard University.

Additional features will be a tour of the city and harbour of Toronto, luncheon topics, and an open session for the discussion of subjects to be submitted by members of the Conference.

Improved Road Machinery

From our London office we have received a copy of a catalogue devoted to stone-breaking machinery manufactured by Messrs. Goodwin, Barsby & Company, Leicester, Eng. The greater portion of this booklet is devoted to material describing and illustrating the various types of "Acme" stone breakers. This equipment is well known to all users of road machinery, but in this new and revised list it is offered in a new series while still retaining the long-tested principles which have built up its excellent reputation. In this new series a high standard of fitting is attained for the purpose of giving to the user of the machine facility for effecting renewals in the shortest possible space of time. Further, by the high standard in quality of material, the longest life in these renewals is ensured.

The bearings in this series are machined, carefully lined and bedded into bored seatings and are thus instantly renewed. The jaw faces and side plates are of manganese steel of the first quality, combining both toughness and the hardest wearing surface.

The machinery manufactured by Messrs. Goodwin, Barsby & Company is well and favorably known in Canada. Tar-macadam mixers, drying apparatus, tar boilers and tar spraying machines are only a few additional lines which have been tried in this country and found to meet exacting requirements.

The Gravel, Sand and Crushed Stone Company, Limited. Toronto, incorporated in 1913, have this month completed at their property at Erin, Ont., one of the most up-to-date plants in the country for the up-to-date grading of sand, gravel and crushed stone. The property consists of upwards of 35 acres, situated on the C. P. R., with a siding running the entire length. The company have gone down to a depth of thirty-five feet and the quality of the sand and gravel was maintained as far as the shaft was sunk. The property is 1,100 ft. above Lake Ontario, and it is characteristic of the material that there is an absence of clay, loam and organic matter. The company have practically no stripping to do. At present about twelve to fifteen cars a day are being turned out. Contractors requiring clean, sharp sand, screened gravel and crushed stone are invited to communicate with the firm at 122 William Street, Toronto.

Mr. F. C. T. O'Hara, Deputy Minister of Trade and Commerce, has notified Mayor Frink of St. John, N.B., that he is to give evidence on harbor facilities before the Dominion Royal Commission, an Imperial body which will begin sittings in Canada next August.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **May 6, 1914** **No. 18**

Principal Contents

Protection of Elevated Tanks and Standpipes from Frost ... 539
Municipal Engineers and Experts ... 540
Day Labor vs. Contract Work ... 541-3
By J. W. Astley
Underpinning Work-House Adjacent to Tilting Grain Elevator at Transcona ... 543-4
Ford Motor Company's Proposed New Building ... 545
The Modern Type of Cement Gun and Its Work.. 546-51
Part II. (Conclusion)
Reinforced Concrete Factory Construction ... 551
Keeping Reinforcement in Place ... 551
The Efficient Operation of Water Purification Plants 552-3
By H. P. Letton
Process for the Utilization of Sewage Sludge ... 554
New Water Supply for Winnipeg ... 555
New Sewage Disposal Plant in Worcester, England... 555
Rerolled Reinforcing Bars Tested ... 555
Building an Eighty-five ft. Chimney in Seven Days ... 555
The Quebec Bridge Anchor-Arm Spans ... 556-8
The C. P. R. Terminal Improvements at Vancouver.. 559
Toronto's Proposed New Union Station ... 560-1
Constructional News, Personal Mention, Industrial Notes, etc. ... 562-6

Protection of Elevated Tanks and Standpipes from Frost

THE necessity for protecting elevated tanks and standpipes from the extreme cold which prevails at times during the winter in Western Canada is emphasised by the experience which the town of Moosomin, Sask., had with its standpipe last winter.

The tower is 80 ft. high by 16 ft. in diameter, and has a capacity of 100,000 imperial gallons. It is not housed in, and during the very cold weather an ice cap forms near the top. It is the aim of the authorities to keep the water as near the top as possible all the time, but there are times when the water drops lower than the ice cap.

On Saturday, February 14th, water was being pumped into the tower after a spell of severe weather. The man in charge of the pump was away for about fifteen minutes and on his return he found the pressure gauge had made a complete turn and was pointing beyond the 10 lb. mark, which would represent a pressure of probably from 130 lb. to 150 lb. a sq. in. Immediately he stopped the pump and opened a valve, letting off water and so reducing the pressure. An examination of the tank showed a leakage about the base and also two of the anchor bolts broken. Various opinions were expressed as to what had actually happened, and the writer was asked on the information given above to express an opinion as to what actually happened and to suggest the best means of avoiding any further trouble.

Owing to the pressure of 150 lb. due to the pumping there would be a very considerable upward pressure acting on the ice cap. Also there would be an equal and opposite pressure acting on the bottom. As the bottom rests on a concrete foundation it could not "give." The tendency would be for the tank to rise, and of course failure would occur at the weakest point, which would be at the bottom, where the flange angle on the vertical plate is connected to the bottom plates. The stress would come on the rivet heads, and there would be the slightest amount of movement, which would cause leakage between the angle and the plate.

If the anchor bolts were slack, this movement would probably not be enough to cause them to fracture. The two which broke were possibly already under severe stress before the additional load due to the tank rising came on them. This condition might easily arise from the fact that the plate of the standpipe to which the bolts are connected would be at a temperature above freezing due to the water inside, and the bolt would be at a temperature considerably below zero. The result would be that the bolt would contract and tighten up and on account of the brittleness due to a severe cold it would snap. As it actually happened, the leakage was between the flange angle and the bottom plate.

Regarding the lessons to be learned from the above occurence, it is obvious that too much care cannot be taken where a town or municipality is dependent upon a standpipe for the distribution of its domestic supply of water, and the best precautions known to prevent any failure should be taken. The business, health, comfort, sanitation and the best well-being of the community are dependent on the continuity of the supply of water. The town of Moosomin is fortunate in that the damage done was so slight. As long as no protection is given against the severe cold of this western country there is always danger.

In designing standpipes or any structures all known dangers are guarded against. A factor of safety is used for the steel, the strongest possible wind stress with the tank in the worst condition to withstand it is taken into consideration, and in very many cases in this country and the United States the danger due to the formation of ice is left out and the stand-pipe is left unprotected. Is this intelligent design? Does the saving made in the frost casing warrant taking chances when one takes into consideration how much depends on the continuity of the supply of water?

Many dangers are ever present and these, in some cases have caused complete failure. With a favorable combination of circumstances, the tank might be empty and the ice fall. The rivet shear might be increased beyond safety on account of the possible suspension of ice, or—on the withdrawal of water—on account of the formation of a vacuum and the increased stress due to atmospheric pressure, far beyond anything considered in the design. These and other possible dangers, such as happened to the Moosomin tank, all go to show the absolute importance of so protecting standpipes that there is no chance of ice forming within.

This can best be done by building around the standpipe a wooden casing, some few feet from the steel, to allow of stairs or ladders to the top, and heating this space possibly by means of the exhaust steam from the pump house or by some other means. The importance of this protection cannot be impressed too strongly on all towns or municipalities that are compelled to build stand-pipes to distribute their domestic supply of water.

Municipal Engineers and Experts

"There is no field of municipal work where the engineer has the opportunity to develop greater versatility than in the moderate sized city, according, say, with cities of the second class in New York State. Here the city engineer, appointed by the mayor, is a voting member both of the board of estimate and apportionment and of the board of contract and supply. He is called upon to exercise control over almost every kind of public work incidental to the modern city. The work may not be of the magnitude to be found in the greater cities, but its variety is far greater than that which comes to the engineer of cities of the first class, where jurisdiction and responsibility are subdivided. Having less of a certain kind of work to do, he takes it very seriously and it is often exceptionally well done.

"The practice of electing a city engineer by the council or other legislative body, or, as is done in some cases, by popular vote, cannot be too strongly condemned. Past experience has given good ground for the general statement that no man should be selected to do professional or highly technical work by election, whether that election be by the general public or by a legislative body. Those who are called upon to vote for candidates for such an office have no means of knowing their peculiar qualifications, or lack of qualifications, and better results will almost invariably be obtained if responsibility for the appointment of a man to do such work is vested in the chief executive of the city."

The above is part of an address delivered by Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment of New York City, before the graduate students in highway engineering at Columbia University; and there are two points in this brief quotation which seem to us to deserve special recognition—the reasons advanced for appointing rather than electing a city engineer; and the great variety of the work which he must undertake and the fact that this is "often exceptionally well done."

With the latter point we are frequently impressed as we come into contact with engineers of the smaller cities. The duties of the city engineer of a large city are often more executive than technical, and both he and his subordinates are too overwhelmed with details to give adequate study to the problems presented; and so for year after year they follow standard methods, use standard plans and specifications, and depart from the old standard of practice only after most of the more progressive moderate sized cities have led the way.

The city engineer of a medium-sized city has, in fact, unusual opportunities for obtaining wide engineering experience, since he is called upon in many cases to act as designing and constructing engineer in connection not only with sewers, water works and street pavements, but also bridges, street railway tracks, buildings, river improvements, retaining walls, and almost every kind of structure which is included under the head of engineering.

That he should be an expert in all of these branches is impossible; that he should be even reasonably competent in all of them is hardly to be expected, when we consider that, for the salaries ordinarily paid to city engineers, young and comparatively inexperienced engineers only can be obtained. City councils should realize this, and city engineers should not be ashamed to confess it, since it is certainly in no way to their discredit, and to seek expert advice on important or novel work.

Probably in no one feature are American cities so far behind the most successful European ones as in the proper utilizing of expert services—expert mayors as well as expert engineers; and city engineers should not only consider it as no reflection upon their ability, but should even recognize it as a duty to their city and to their profession, to insist that when they are called upon to undertake any important work, the city should employ an expert in that particular line to advise them. None but a large city could, of course, expect to retain on its payroll experts in various lines or even in one line; and an expert in one line would probably be less effective in carrying on the general routine work of a city engineer than the average man that fills that position.

The city engineer's duties are most diverse and important, and when well carried out deserve as much credit and may require as much talent as those of the best paid consulting expert. But part of his ability is the recognition of the times (which will come in the history of most of them) when the best interests of the city as well as his own reputation call for the advice of an expert in the particular subject involved, and he should not hesitate to urge that such advice be obtained. On the other hand, the city should not expect the

1914 28(18)

engineer to pay for this advice, but should do so themselves; since they should realize that the salary which they are paying is not sufficient to engage for them expert knowledge in a dozen different branches, or probably even in one, but that the engineer, although not a specialized expert, is probably giving them more than their money's worth in carrying out the ordinary work entrusted to his charge.—Municipal Journal.

Day Labor vs. Contract Work

Specially contributed by J. W. Astley.

BEING often asked by head officials of towns and cities as to my opinion in regard to the question of day labor vs. contract work for every class of municipal work, and as the Contract Record is taken by nearly every municipal contractor and has a large circulation among engineers, I am submitting this article for the benefit of city officials, who, from their own knowledge and from the criticisms of contractors, will be able to form a very fair opinion on the question.

I may state that in forty-five years' engineering experience, I have had, for ten years, the responsibility of handling every class of civic work by day labor. For the last six years I have carried out this work under a system somewhat different from what is usually employed. In this respect I tender against outside contractors, who are furnished city material at the same prices that I am charged. In my tenders, I include the following overhead charges: interest, sinking fund and repairs to all machinery, time-keeping, book-keeping, superintendence, and a percentage for operating stores department.

A contractor has to carry his own fixed charges, so that practically the only difference between day labor, as I have to carry it out, and work done by a contractor is that I put up no deposit and the city becomes my security for the due fulfilment of the work. The inspection is supposed to be the same, but it is carried to the extreme in my case, so as to prevent any loophole for complaints. I am expected to carry out my work for my tender prices, and I have done so with very few exceptions. The average yearly value of work for the last six years has been close to $1,000,000.

A detailed statement is submitted at the end of the year and is published, so as to give the general public a chance to see the results of day labor. I am giving a plain statement of facts, as they carry great weight in regard to this question.

The city of Winnipeg owns and operates the following public utilities: unlimited electric power for light and power purposes, water-works—domestic and high pressure, gravel pits, stone quarry, crushing plant, railway cars for handling material; one stationary and one railway asphalt plant, storage yards with overhead supply bins, and machine shop equipped with up-to-date appliances; stores department, gasoline trucks, tractors, rollers, sewer machines,—in fact everything that makes a contractor's outfit for certain classes of work and a certain amount of work.

The cost of material is as follows: broken stone, delivered, per cubic yard, $1.75; cement, in stock, per bbl., $2.10; gravel, delivered, per cubic yard, $1.25; asphalt, per ton, $25.00; flux, per ton, $22.50; limestone dust, in stock, per ton, $4.50; crushed granite, per cubic yard, $3.50.

Fixed charges are kept sufficiently high to leave a safe margin on an ordinary season's work. Naturally, if a very big season's work is carried out, more is raised than would cover what was calculated as wear and tear, etc. This extra amount is used to further reduce capital accounts on various plants.

Standard asphalt pavement, 3-in. ballast, 6-in. concrete, 1½-in. binder and 2-in. surface, costs $2.65 a square yard. This includes superintendence and time-keeping, 3c; sinking fund, interest and upkeep of plant, 7c per square yard; maintenance charge, 20c. Total 30c per square yard.

Extra fixed charges on all works:—

4 per cent. on labor for general tools and plant.

3 per cent. on cost of stores for operating same.

3 per cent. on labor for superintendence and time-keeping.

$15.00 per day for use of large concrete mixers, smaller size, $7.50.

$15.00 per day for steam rollers. $25.00 per day or its equivalent for gasoline tractors.

$25.00 per day for sewer machines.

These charges are exclusive of engineers' and helpers' wages.

The price per square yard for artificial stone sidewalks, of which there were 84 separate contracts last season, was:—

For residential streets, 8-in. gravel base, 4-in. concrete and 1-in. finish, per square yard .. . $1.55
For business streets, 8-in. gravel base, 5-in. concrete and 1½-in. finish, per square yard $1.65

Prices per foot for 6-in., 8-in., 10-in. and 12-in. water mains were 27c, 30c, 35c and 40c respectively. This includes lead, hemp, and connecting to existing mains and hydrants. All water pipe and specials are furnished free by the city.

Prices for 12-in., 15-in. and 18-in. pipe sewers were 65c, 75c and 90c. These prices include all except cost of pipe.

Concrete sewers—The general average of cost of concrete is $8.00 per cubic yard, and excavation, 50c per cubic yard. I may state that this class of sewer is generally very deep, and our ground is known to be very treacherous, thus preventing the use of certain classes of sewer machinery.

With the aid of these prices and our fixed charges, contractors and city officials in other localities will be able the more readily to adjust any difference in cost of labor and material.

It will be seen that by having our own plants, we are well fitted to carry out a large amount of work and thereby keep our machinery working as many days as possible during the working season. At the best, in this climate, six months in the year is the most you can calculate on to make any machinery earn towards its cost of upkeep.

At the same time, it often occurs that tenders are called for more work than can be done in a given time by the machinery we own, and as it would be a poor policy to expend $10,000 to $12,000 for extra machinery simply in cases of this kind, outside contractors, in such instances, are expected to get this extra work. At

---

[1] Engineer of Construction for the City of Winnipeg.

the same time, however, prices are kept down to a fair basis by the knowledge that the city could handle all the work if they wished to do so by purchasing more machinery.

Another very important fact that must not be lost sight of is that no matter how much or how little work a city may have, they cannot do work outside of their own civic works so as to try to keep both their men and machinery steadily employed. A contractor has this privilege, and can tender on other work as well, thereby giving him a chance to keep a well-organized gang steadily at work. Also the fact must be borne in mind as regards all civic works, that seldom is any endeavour made to order different undertakings so that one could be completed before the next is started. They are all usually ordered together, and must be carried out at once, as they are wanted immediately, for the simple reason that many of these expenditures have been put off as long as it was possible to do so with public safety. The city powers that be cannot be blamed for this, as it is only too often simply a question of finances.

Outside of a city having reasonably up-to-date plants, without having gone to the extreme for reasons given in a previous paragraph, they fail to do as cheap work as a contractor unless a competent man is given full control of men and machinery, and held responsible for the cost of the work. This is as good security as that put up by any municipal contractor, as any man who is fit for the position should never be put there by civic influence. He must stand or fall by past and present record, and any question of whom he shall hire must be cut out. In plain language, cut out ward patronage or quit day labor once and for all.

It may be considered by many that our fixed charges are excessive, but this is one item that is not given sufficient thought by city officials when contemplating the day labor question. Contractors have it drawn to their attention very forcibly when their hands have to go into their pockets for new machinery. My idea on this subject has been formed from many years' use of every class of machinery and I believe that as the city cannot claim or make use of any direct saving in the cost of any work, such saving going to the benefit of the property owners direct, a liberal collection should be made which would leave the cost of the work at a reasonable figure.

By this means, after the assumed life of any machinery is passed, and consequently paid for, it can be scrapped if thought advisable, either on account of the cost of the yearly repairs exceeding one-half the expected revenue, or because it has become out of date. The question of machinery becoming antiquated is a much more important one than many people think. Many classes of machinery are out of date in five years, where the life might be safely placed at ten years. Once the saving on operating on account of any improvement will more than pay for the general upkeep of the older machine, it is time to scrap it, otherwise your outfit will be going further behind before the next change occurs.

It can also be taken as a fact that will bear no question of an argument, that the average of all work will be of a better quality than if done by many so-called municipal contractors. Many of this class of contractor is here to-day and gone to-morrow, and as very often happens in municipal work, many unforeseen difficulties crop up that cause the work to be more expensive than was assumed, and still cannot be claimed as an extra. A contractor, unless he is overburdened with cash, must slip over these places at the least loss to himself, whereas the city can, and should, afford to expend whatever is necessary, even if by so doing the cost over runs the original tender price.

If it was possible for one or two reliable municipal contractors to be awarded all city work, it would be a different matter. They would then have the same incentive to do this work as a lasting record to themselves. If a town or city decides to adopt the day labor principle, there are many things that they had better leave alone, especially large buildings and certain classes of other work that only come once in a while, and require a different plant than that in general use. This would mean carrying a large outlay in dead plant, besides requiring certain skilled labor that is too high-priced to be used on any ordinary work; consequently on these odd jobs you would only get the left overs in the way of skilled labor, which is dear at any price.

Winnipeg Procedure

After tenders are advertised for and bids are received, the tender which is lowest is recommended by the Board of Control to the Council, and if my bid is accepted I am notified to proceed. You will thus perceive that the two governing bodies of our municipal system have made themselves responsible to the people for the due fulfilment of the work, both as regards the time limit for completion, and the stated cost of the work. Under the circumstances, I consider that I hold a very responsible position, having the reputation of the two civic governing bodies as well as my own at stake, and must "make good."

I will state that I have never been asked by any members of the Board of Control or City Council to accept any man as foreman on these works. The same applies to laborers. If this system is carried out, day labor can be made a success, and the average cost of all work will be cheaper than any contractor can afford to do it for.

There are exceptional cases when, if a contractor wishes to keep his gang together for other work he had in view, he can afford to take civic work at cost prices, in which case if he comes out clear, he has actually made it pay, as the loss in wages of making up a new gang amounts to a considerable sum in dollars, besides the question of efficiency in keeping a well trained gang ready for the next job.

Winnipeg was the pioneer city to go into the question of building and operating their own municipal asphalt plants and doing all their own asphalt work. The effect of all this class of work being done by the city is very apparent. We can justly claim a more even quality of good pavements and cheaper to keep in repair than any city on the American continent. This is simply owing to a uniform system being carried out in regard to mixing and laying pavements from year to year, any repairs being made as required, not to suit the time and convenience of various contractors as would be the case if repaired under the guarantee system. It would not be possible to lay as even a class of pavements if several contractors were engaged in the work during different years, and the figures given in a previous paragraph will show that no contractor could afford to compete and make a fair margin of profit.

To make it pay a town or city to go into this class of work, they should be able to see that under ordinary conditions a certain amount would be required every year. If there is a rush one year and very little done the next, it means carrying over overhead charges to a second year, which is not a good policy, but if sufficient asphalt pavements are already laid that are past their guarantee period, and there are others that still have some years of the guarantee period yet to run, these two can always be counted on to make a certain amount of work for a municipal asphalt plant, and will help to carry the overhead charges.

I am a firm believer in day labor if carried out as a business proposition, but if attempted to be carried out as in many cities south of the line and in many of our own Canadian cities, under the old style of city council and ward politics, it cannot be made a success. It simply means taking the property owners' money and distributing it among the working class, under the mistaken idea that the city is better off because many men who are residents receive employment on civic works, but which no contractor would hire at any price except to fill a gap until he can pick up something better.

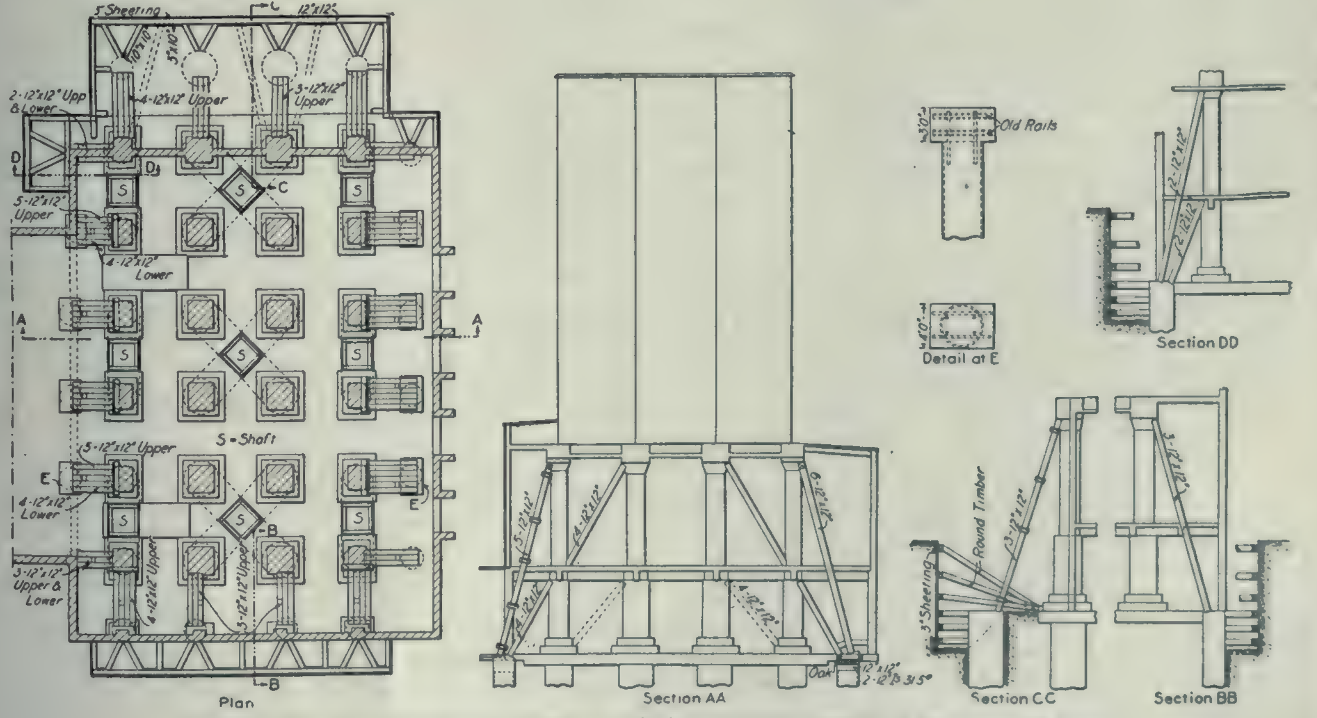
I have seen civic works carried out by so-called day labor on both sides of the border, under practically the above system, and the estimated extra cost was at least 30 per cent. over what it should be, but as the old saying is, "the people get what they want and so have no kick coming."

Underpinning Work-House Adjacent to Tilting Grain Elevator at Transcona

To forestall the settling of the tall, heavy work-house adjacent to the Canadian Pacific Railway's grain elevator at Transcona, Canada, which is leaning at an angle of 24 deg. to the vertical as a result of recent subsidence of the blue clay foundation, a contract for underpinning has been awarded to the Foundation Company, Limited, of Montreal. The main elevator settled 26 ft. on one side and was thrown 30 ft. out of plumb in a height of 102 ft., but no material settlement has yet been observed in the work-house. The underpinning work is now in progress and consists essentially of a method of affording preliminary support for the entire superstructure on inclined shores, and subsequently sinking shafts to rock under the column centers and constructing in them new footings on which the building will be underpinned.

The 45 x 70-ft. work-house is 152 ft. high above the ground and extends 16 ft. below ground to the top of a monolithic concrete foundation slab 4 ft. thick which is heavily reinforced and receives the square footings of twenty-four cylindrical columns arranged in four longitudinal rows. The estimated total weight of the building and contents is 5,640 tons. The interior columns each carry 313 tons live load and 415 tons dead load, while the exterior columns carry 157 tons live load and 215 tons dead load. The foundations rest on a bed of clay about 40 ft. thick, below which there is a stratum of gravel and disintegrated rock extending to bed rock about 54 ft. below the surface.

The unstable condition of the soil, demonstrated by the excessive displacement of the adjacent building, made it very hazardous to disturb these foundations until independent support was provided for the super-



Details of shoring and arrangement of shafts and drifts for underpinning columns of Transcona work-house.

structure. The entire weight of the building was therefore transferred to temporary new foundations through a system of inclined shores on exterior piers with a factor of safety of three.

A sheeted trench, heavily braced with 12 x 12-in. horizontal timbers, was excavated around all four sides of the building to a depth below column footings, and in it twenty foundation pits were sunk to rock opposite the exterior columns and about 10, 13 and 15 ft. distant from them on centers. The two pits at each corner, eight in all, were excavated inside a sheeting of sectional cast-iron cylinders with courses 4 ft. high, which were loaded with steel rails suspended from an upper platform.

The experience and information obtained by sinking these pits enabled the contractor to sink the remaining pits, 5 and 6 ft. in diameter, by the Chicago method, substituting for the cast-iron casting vertical wooden staves with inside flanged steel rings. The piers on the longitudinal sides of the building were filled with 1:2:4 concrete and the larger ones at the ends were filled with 1:3:5 concrete. They were capped with enlarged rectangular pedestals to receive the feet of the inclined shores. The thrust was resisted by horizontal rails embedded in the concrete and bearing against vertical rails reinforcing the top of the pier and distributing the stress into the pier shaft.

Transferring Column Loads

The column loads were all transferred to the new exterior piers by a system of heavy multiple inclined shores transverse to the longitudinal axis of the building. These shores were arranged in pairs, one shore of each pair engaging the adjacent exterior column at the second floor, and the other engaging the adjacent interior column in the same transverse plane at the second floor level. The corresponding pair of shores in the same plane on the opposite side of the building completed the support for one transverse row of columns, and with the solid floor connecting the columns formed an arch-like construction through which the total weight of the upper storeys was transferred to the new outside piers. Provision was made for the insertion of additional bracing from the bottoms of the exterior columns to the first floor, as indicated by dotted lines, but their use has not been found necessary. The tops of the exterior foundation piers and some of the footings of the columns in the building are braced by raker struts to the bank on the outside of the trench.

Underpinning

The shores are made of full length 12 x 12-in. timbers, from two to four in a set. In the heaviest long shores the separate pieces lie in the same inclined plane and are thoroughly clamped together with yokes made of a pair of screw rods with nuts engaging bearing angles on the opposite sides of the struts. The upper ends of the outside two-storey shores engage horizontal bearing pieces or caps consisting of 12 x 12-in. timbers 6 ft. long reinforced by a pair of 12-in. channels fitted on opposite faces and securely bolted to them. These pieces are set in seats cut out of the concrete at the tops of the columns, and distribute the shore pressure over the entire width of the concrete. The other shores have their ends bearing directly against the dressed surface of the concrete. The shores were adjusted and brought to bearing by heavy oak wedges at the lower ends.

The monolithic concrete slab which forms a continuous footing under the entire area of the building will have nine openings cut through it to give access for the underpinning excavation. These openings, about 6 ft. square, will be located so as to give access to the greatest number of columns without involving unnecessary cutting of the foundation slabs. Three of them will each give access to four interior columns, and the outer ones will each give access to two exterior columns.

From these openings excavations will be sheeted down about 6 ft. below the bottom of the concrete and drifts will be run from them to the centers of the adjacent columns under which shafts will be excavated by the Chicago method already described, carried down to rock, and filled with concrete, adjusted to bearing under the column bases so as to continue the support of the latter directly to solid bearings.

Each shaft will be equipped with a small individual electric hoist, and the spoil buckets will be suspended from trucks engaging horizontal tracks on which they will be carried through the drifts to the common opening in the foundation slabs. In the excavation of the exterior shafts for the shoring piers, the spoil buckets were handled by windlasses operated in groups by a rope drive.

The work is being executed under the supervision of A. I. Campbell, superintendent for the contractors, and Frank Lee, principal assistant chief engineer in charge of the work for the Canadian Pacific Railway Company.

City Engineers vs. Private Engineers

An engineer of wide experience both in municipal work on salary and in private practice raises a question of engineering ethics. Should engineers on city payrolls at presumably full-time salaries, and with no private offices and no personal staff, compete for outside work with engineers who have to maintain both?

In such cases the public official or employee has no office rent to pay, and if he has sufficient energy and executive ability he can call to his aid his fellow employees and thus carry on a business of considerable magnitude practically clear of all charges except those for strictly personal services.

Two main points are more or less deeply involved: (1) The two-thousand-year-old question, "Can a man serve two masters?" with its well-known and generally accepted answers; and (2) fairness of competition with engineers in private practice who must meet office rent and other overhead charges. The chief danger as regards unfair competition lies in the temptation to take advantage of lack of overhead charges and to offer to work for lower fees in order to get more engagements or engagements more easily. This danger could be obviated by charging a standard fee—if there is such a thing that can be adjusted to various degrees of education, experience and ability.—Engineering News.

Among the most important foreign bridges now under construction or completed last year there were recently enumerated in the "Engineer" the Sara railroad bridge over the Lower Ganges, comprising fifteen 359-ft. spans, with foundations carried down to a depth of about 162 feet below water level. It is being built at an estimated cost of more than $6,000,000. The Allahabad railroad bridge in India is 1¼ miles long and has forty 150-ft. spans. The Potergy River bridge in Brazil has ten 164-ft. spans. A viaduct on the railroad from Miramas to L'Estaque in the south of France is 3,093 feet long.

Ford Motor Company of Canada, Ltd.
Ford Motor Company of Canada Ltd

Ford Motor Company's proposed new factory at Toronto. Estimated cost $250,000. Architect: Mr. John Graham, Detroit. Contractors: F. J. Mark Construction Company, Birmingham, Alabama.

Ford Motor Company to Have Fine New Factory at Toronto

REPRODUCED herewith is the architects' perspective of the new factory which the Ford Motor Company of Canada propose to erect on the northwest corner of Christie and Dupont streets, at a cost of $250,000. The new addition will be five storeys high and the exterior will be of face brick trimmed with terra cotta. The building will be absolutely fireproof, and the flat slab construction, giving a maximum span between the columns, will be adopted. A roof, paved with tile, will afford 21,000 square feet for testing. There will be two large freight elevators, one running to the roof, and two service stairways. A covered loading platform will enclose a space 95 ft. by 50 ft. The floor area of each floor will be 21,320 sq. ft., and the floor area of the entire building, not including basement and roof, 106,605 sq. ft. The heating apparatus will be installed in the basement, which has an area of 5,000 sq. ft. Excavations for the building are now in progress. The architect is Mr. John Graham, of Detroit, Mich., and the general contractors are Messrs. F. J. Mark Construction Company, Birmingham, Alabama.

Contraction and Expansion in Buildings

IN order to determine the effect of temperature upon a new building recently constructed in Cambridge, Mass., the Aberthaw Construction Company has had made by Professor Howard, of the Massachusetts Institute of Technology, some very carefully standardized measurements of the Gray & Davis 5-storey reinforced concrete factory, erected by them in 1913 from designs of Monks & Johnson, of Boston.

The building is about 381 ft. by 61 ft., the floors being of the mushroom or flat-slab type. The outside is embellished with a tapestry brick veneer on corner bays, and also on curtain walls below the windows above the first floor.

The first measurement, made on a sunny morning, November 7, 1913, showed a temperature on the ground in front of the building of about 70 deg. F.; while that on the roof, where the upper measurements were made, was about 57 deg. F., being in the shade of the parapet wall. Points for measurement were established at the corners of the building, by round-headed brass screws set into lead expansion shields and well anchored into the concrete wall. Intermediate points, established by stakes driven into the ground approximately 100 ft. apart, were on the same level as the two end points and exactly in line with them.

Measurements were made three times to obtain averages; and the temperature was taken by three standardized thermometers—one at each end, and one at mid-length. After making all corrections to the steel tape used, the length was found to be 382.559 ft. at a mean temperature of 69.8 deg. F.

The measurements in the upper part of the building, made from the roof, were located about 3 ft. above the roof level, and were set in the same way as those in the bays. Three separate measurements were made here also, the final length being found to be 379.437 ft. at 56.9 deg. F.

February 12, 1914, on a cold day following several cold days, three measurements at the base gave an average of 382.552 ft. at an average of 17.4 deg. F. Three measurements on the roof gave a mean length of 379.377 ft. at a mean temperature of 6.2 deg. F.

These measurements seem to indicate that the upper part of the building contracted .06 ft. in a range of 50.7 deg. F.; the base line contracted .007 ft. in a range of 52.4 deg. F.

In addition to direct measurements, vertical lines were established between the bottom and top of the building. The top point at the west end of the building was found on February 12 to have moved east .02 ft. The top at the other end of the building was found to have moved west .026 ft. Three intermediate points all moved well in amounts varying from .01 to .024 ft. This bears out the generally accepted idea that a building contracts more at the top than at the bottom in cold weather, and correspondingly expands more at the top than at the bottom in hot weather.

The Modern Type of Cement Gun and Its Work[*]—Part II. (Conclusion)

By Carl Weber

REMARKABLE as an example of repair work are the concrete piers of the Dover Street Bridge in Boston. Fig. 12 shows the condition of the piers after the worst rubbish had been cleared away and also very plainly shows the line to which the tide rises at regular intervals. During high tide the piers are almost completely under water and therefore ordinary repair work would have required the construction of a temporary cofferdam around the pier. It was then decided to use the cement gun for this work and Fig. 13 shows the successful completion of the work.

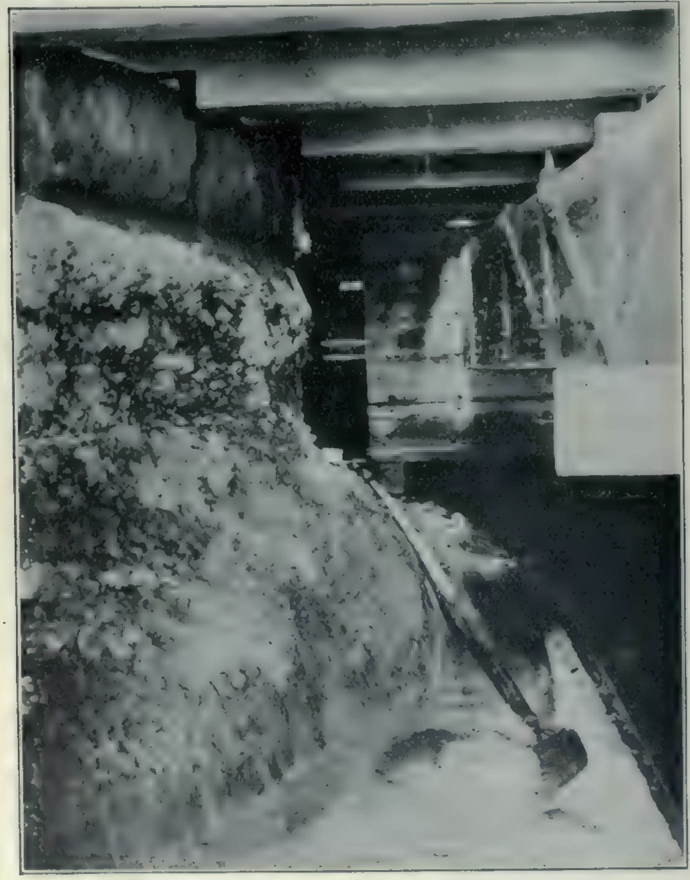


Fig. 12—Concrete piers, Dover Street Bridge, Boston.

All the work was done between tides, without any forms or other equipment. Fig. 13 shows very plainly the tidemarks on the new work. The cement gun deposited the material with such force, and compacted the same so densely, that even the rising tide could do no harm to the new gunite work.

The same conditions had to be met on the repair work of the sea wall at Lynn, Mass., and on numerous other jobs all along the Atlantic and Pacific coasts.

In Fig. 14 the cement gun is shown on tunnel repair work. The brick lining in the single track tunnel on the Chicago, Milwaukee & St. Paul R. R. near Tunnel City, Wis., was badly worn by the locomotive blasts. The mortar filling on the roof had been so damaged and the lower course of bricks so worn away that repair work became necessary. The tunnel is 1,330 ft. long. There being an average of 32 trains per day at this point, and all tonnage freight being operated with pushers, this allows very short working time between trains and therefore the repair of the tunnel was a difficult problem. The method finally adopted was to place a gunite coat over a strip 8 ft. wide on the under side of the centre of the arch and the results have been satisfactory.

Before placing the gunite the surface was cleaned with a sand blast. No. 3 triangular mesh reinforcement was used in a single layer and placed in 8 ft. lengths at right angles to the tunnel axis. The gunite was applied in two to five coats, depending upon the thickness necessary. The concrete never extended into the old lining for a distance greater than the thickness of one brick and projected 2 in. beyond the old face of the lining. This made the total thickness vary from 4 to 6 in.

In planning for this work it was thought that some form of shield would be necessary to protect the fresh concrete from locomotive blasts until it had thoroughly set, and a movable shield to be supported from the roof was accordingly built and used at the beginning of the work. It was soon found, however, that the cement placed by the gun was so hard immediately after placing that the locomotive blasts had no effect upon it and the use of the shield was discontinued.

The portable compressor plant was located at the east portal, a 2 in. pipe was carried through the tunnel with connections at frequent intervals, and the cement gun and mixing board were carried on staging supported by two standard gauge cars coupled together. A Fairbanks-Morse gasoline locomotive was used to push the equipment in and out of the tunnel. It was necessary to remove the entire outfit to a siding at the east portal for every train movement. The work was carried on for about two months, the progress being about 210 ft. a week.

Another interesting piece of railroad work is shown in Fig. 15. The picture shows a portion of the deep rock cut on the Erie R. R. just outside of Jersey City known as the Bergen Hill Cut. The work of the cement gun consisted in cleaning the fissures between the different layers of the rock and then filling them with cement mortar to eliminate the danger from falling rocks and to retard disintegration. The hanging platforms used for this work and the simplicity of the whole arrangement are shown.

Of an entirely different nature is the work shown in Figs. 16 and 17, which illustrate a coal bunker about 25 ft. wide, 20 ft. deep, and 150 ft. long. This coal bunker, which is built at the Haskell-Barker Car Company's works at Michigan City, Ind., was lined with gunite in order to protect the bunker against abrasion and the action of the sulphur in the coal, which will weaken the steel work in a short time. The lining is 2½ in. thick, reinforced with No. 7A American Steel

---

[*] Abstract and re-arranged version of a paper presented last month to the Western Society of Engineers, Chicago, and published in the April ournal of the Society. In co-operating with the Editors of the Contract Record in the reproduction of this paper (in two parts, in the issues of April 29 and May 6), Mr. Weber kindly offers to deal directly with any enquiries through our correspondence columns.

& Wire Company's triangular mesh. This mesh is fastened to angle irons riveted to the steel work for that purpose. The work has proven successful and although no provisions whatever were made for expansion joints, not a crack appeared in the work.

There is a large field for this class of work, as practically no protection is given the steel work in such bunkers at the present time. The saving in cost for repair and renewal is soon equal to many times the cost of the gunite lining.

Numerous old and new steel bridges and viaducts have been coated with gunite to protect the steel work against rust and the corrosive action of the gases emitted by locomotives, etc. The gunite covering also deadens the noise of traffic over these structures and greatly improves their appearance.

For old bridges, where the corrosion has gone so far as to practically demand renewal, the cement gun suggests the reconstruction at a saving in cost by a new process. The steel work after having been cleaned and freed from all rust, scale, and loose paint, is wrapped with wire mesh. To make up for lost steel area and to provide additional strength, reinforcing bars may be placed as in ordinary practice and then the whole structure coated with gunite from 2 to 6 in. in thickness as conditions may demand. In this manner the old structure can be saved, practically a new bridge being formed without interruption of service and without any great expense for forms, scaffolding or the like. The reconstructed bridge will then be a permanent structure and of superior strength and appearance to the old one.

Figure 18 shows the new South High Street Viaduct at Columbus, Ohio. The length is about 350 ft. and the width is 70 ft. The steel work of the entire structure, including columns and braces, has been coated with gunite about 2 in. thick and the appearance of the work after completion is illustrated. In Fig. 19 we have a close view of the nozzle at work on this job. The air compressor and gun are standing on top of the steel work, and the wire reinforcement and the process of coating can be seen.

For coating the steel in our modern skyscrapers and other steel skeleton structures gunite has been used with success. In Fig. 20 we have a close view of some of the steel work of the new 56-storey Woolworth Building in New York. In this giant of skyscrapers practically all of the steel work has been protected by covering with gunite.

Use for the cement gun was found in the new Grand Central Terminal Station in New York, where over 3,800,000 sq. ft. of steel work was covered.

Extensive waterproofing work has also been done at the Chicago Stockyards and elsewhere and this branch of the work is rapidly expanding.

For fireproofing purposes, the cement gun is valuable. Old corrugated iron sheds, warehouses, and factory buildings can be transformed into permanent structures even if already badly rusted. The cost for this work is comparatively low and can be carried on in most cases without interfering with the service of the buildings.

The work of repairing the spillway of the Public Service Corporation at Joliet, Ill. The spillway is 90 ft. wide and has a swift current. The material had to be shot across the channel, the gun being located at the other side. Practically all the work had to be done from scows. The work consisted of placing a 6 in. curtain wall over the badly deteriorated face of the foundation wall of the station. This curtain wall is 650 ft. long, 12 ft. high, and is reinforced with ½ in. steel rods and American Steel & Wire Company's triangular mesh No. 7. The greatest difficulty was encountered by the inflow of water due to leaky gates from the station. Numerous drains had to be placed in the work to overcome this trouble. The curtain wall encases and protects the intake pipe for the railroad water supply station which carries water at a pressure of about 90 lb. per sq. in.

From these descriptions and illustrations the value of the cement gun for engineering and architectural work will be appreciated. At a later time I hope to be able to give more explicit information along some new lines now in the stage of development. I refer especially to the use of the cement gun for the manufacture of concrete units for building construction, as, for instance, floor and roof slabs, curtain wall sections, hollow floors, beams and columns, pipes, fences, etc. I am sure that the results will practically open a new branch of reinforced concrete construction. For example, two H-shaped gunite beams, 12 in. high and 12 in. wide, were recently made. The web and flanges are 1 in. thick, reinforced with single layers of American Steel & Wire Company's No. 7A, triangular mesh. The longest span between supports was 12 ft. 6 in. and these extremely light beams were tested up to 500 lb. of live load per square foot of floor space. At this load the final result was the toppling over of the load, beam, etc., which of course fractured the beams. The beams and tests were made in a rather crude way and therefore the results are not conclusive; but these indicated the enormous strength of pre-molded gunite members as compared with ordinary concrete and also the resulting economies. Especially remarkable is the

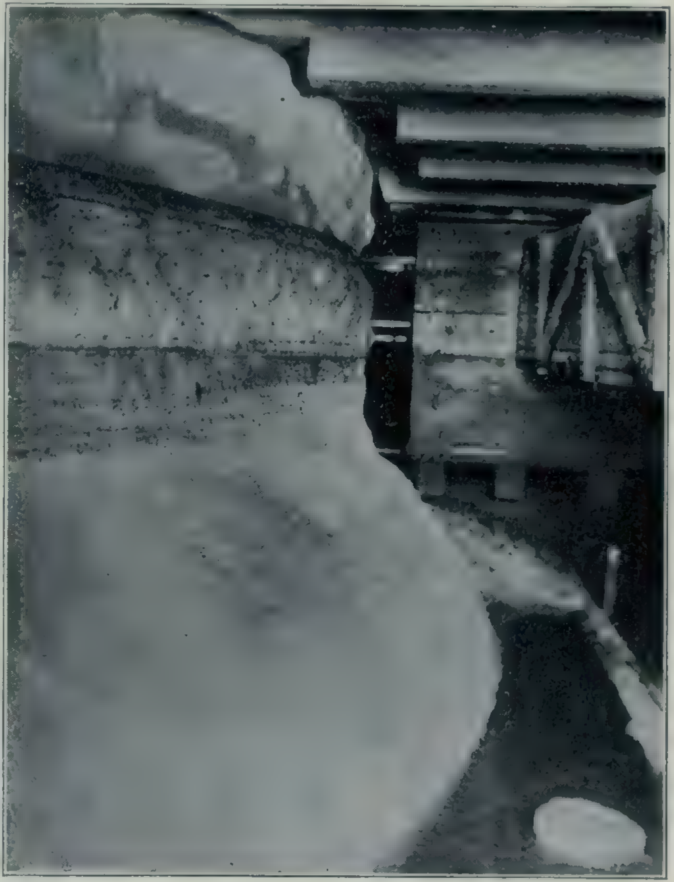


Fig. 13—Same view as Fig. 12, after using the cement gun.

ease with which they can be molded with the cement gun even if of complicated design.

Practical Points Elicited From Discussion

The following abstract of the discussion which succeeded the reading of the paper brings out many interesting points regarding the general utility of the cement gun. The questions were put by various members in the audience, and answered by Mr. Weber.

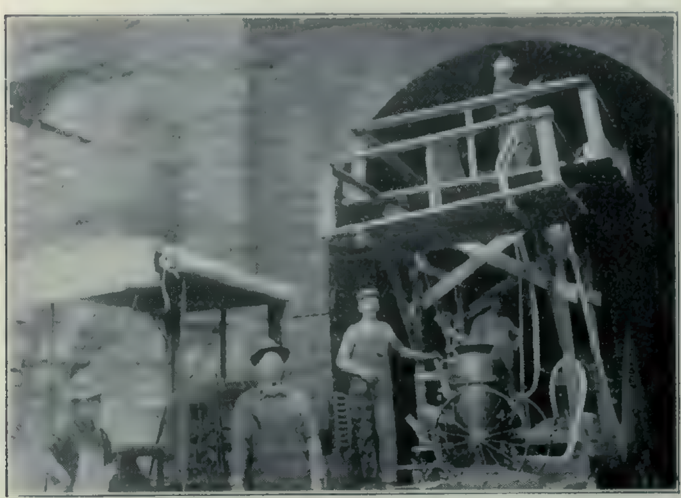


Fig. 14—Use of cement gun on tunnel repair work.

Q.—The author has stated that the velocity of the sand and material from the gun was about 300 ft. per second. I would like to know what is the velocity of the air.

A.—The velocity of the air is, as near as I can remember, about 380 ft. per second. The air, of course, must move more rapidly than the material itself. I might mention that we have, every minute, about 150 ft. of free air discharging through a ¾ in. nozzle, and it is very easy to figure the absolute velocity.

Q.—I notice the author spoke of the material being deposited at 100 per cent. efficiency. If some improvements are made in the gun—as there surely will be in the next ten years—I am wondering what its efficiency will be then.

A.—Any improvements which will be made in the cement gun in the future will be along the lines of greater facility in handling it. These improvements will mean larger guns with greater capacity and an attempt to reduce the cost of operation by finding some way to get along with less air than is now being used. We all appreciate that considerably more power is used than should be necessary according to the best theories. There is at present a great loss and waste in this respect, which we shall probably overcome with improvements. To get greater efficiency out of the material will of course be impossible.

Q.—The mere patching of concrete work has been a thorn in the side of everybody responsible for its maintenance for a generation. If the cement gun offers a way out, which I think it does, that alone is a tremendous achievement. Has gunite ever been applied to wall surfaces to waterproof them against a head of water on the other side?

A.—A good deal of such work has been done in the new Sears-Roebuck plant here in Chicago. On account of the great density of the material, it is especially suitable for this purpose. Of course, we have to insert weeper pipes in the wall to temporarily drain off the water. After the coating has set around these pipes, they can be stopped up. This work has been done very successfully.

Q.—How does gunite resist sea water as compared with ordinary concrete?

A.—On account of the density of the material, the action of the alkali in the water is at least greatly reduced. The action of alkali on cement can take place only if this salt enters the mass and causes a chemical change in the concrete itself; where this cannot take place, naturally there cannot be any destructive action

Q.—In the case of the Woolworth building in New York, what did they do to remove the paint that might be on the surface of the steel?

A.—The cement gun is also a very effective sand blast. We use it for sand-blasting purposes in a great many instances by using sharp sand only and directing the material against the wall at a cutting angle. Paint, rust, and scale are thus easily removed. As a rule, after we have sand-blasted a surface we shut off the sand and go over it again with an air-blast to blow away the last portion of any loose material which may have lodged in the corners.

Q.—Is it advisable to remove the paint from the surface of the steel before applying the gunite?

A.—As a rule, this is done only on surfaces where the paint is affected. But in cases where the steelwork has only the factory coat, if this coat is in good condition it may not be necessary to remove it. If the paint shows defects, it is advisable to remove it before applying the gunite. If it has been decided in the first place to use gunite over steel work, painting is not necessary. In fact, it will be better for many reasons to leave the steel unpainted, because gunite adheres better to unpainted steel. There is a chemical surface action between cement and steel which cannot take place if a coat of paint interferes.

Q.—Do the cement gun people recommend, or is there any decided tendency to use, coloring matter on coating old brick-work, for instance?

A.—That is entirely a matter of taste. It is very simple to apply a colored coat on such structures, and if anybody desires, for instance, to match up the work with brick buildings, etc., he can practically match any shade he may desire. Of course, coloring is a littl

Fig. 15—Deep rock cut on Erie R. R.

more expensive than ordinary work, but it has been done successfully in many instances.

Q.—I have in mind the case of the church in Evanston, where there was a variety of coloring on the face of the building shortly after it was coated. Could not that effect have been overcome if coloring matter had been used? Some of the discoloring has now disappeared, or at least has been very materially reduced.

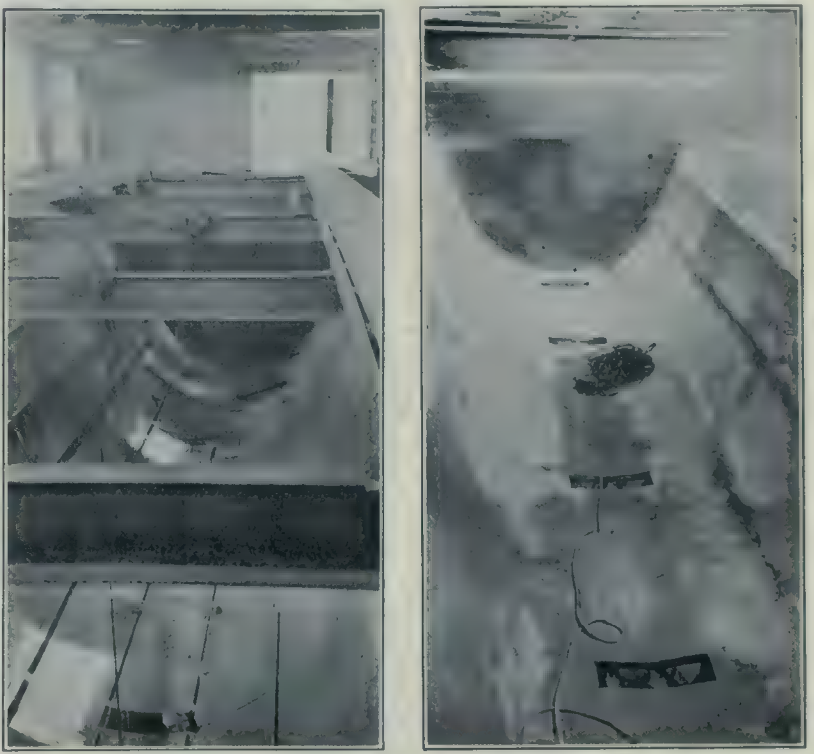
A.—The materials used on the Evanston church job were limestone screenings and cement. It seems as if limestone screenings and any other stone screenings have a greater tendency to discolor than ordinary sand. On a sand coating we seldom have any trouble from spotty coloring.

A Member.—I think a wrong impression might be had with reference to the coating of steel in the Woolworth building. I understand that the coating was put on as a fireproofing and was not necessarily intended to adhere to the steel, but was supported by a metal fabric cage. Possibly this explains why the paint was not cut off. Where the gunite is applied directly to a steel member and is held in place by adhesion, it is necessary, I believe, to clean the steel. We certainly would not want a film of paint intervening between the gunite and the steel. In reference to the waterproofing of a wall against water pressure with the head temporarily removed, this has been done very successfully. The material is so dense and the adhesion so perfect that it becomes part of the original structure. I have seen tests made where the gunite was placed on stone, hard-burned brick, or concrete, and then subjected to a test which would tend to develop the strength of the bond, and in every instance the band has developed as great strength as other parts of the mass. I am inclined to question whether or not the gun people have reached 100 per cent. efficiency; but whether they have or not is not material. We do know that the gun has great possibilities for certain lines of work, and it seems to me the principal thing is the work that it has been doing in repairing the poor work of someone else. We all regret that there is so much poor concrete work and we are equally glad to know that there is some way by which it can be repaired. I wish to ask what it would cost, ordinarily, to place an inch coat, say, on a horizontal surface and also on a vertical surface. On a vertical surface, metal fabric would be required, while on the horizontal surface it would not be needed.

A.—The question which the last speaker asks is a very hard one to answer directly, for the reason that so much depends upon the amount of work to be done in one place. We use a pretty heavy equipment, and to carry this from place to place means expense. That is one portion of the cost. The material requirements for the gunite work are from 20 per cent. 25 per cent. more than handwork, owing to the loss by rebound and the additional density in the material. Therefore, it is very difficult to set a price and make this price stand out as something to go by. We have done work of this kind, 1 in. thick, as low as 70 to 80 cents a yard, while other jobs have run up to $1.50. That, of course, includes the reinforcement which has been used. Overhead work is a little more expensive than work on the side walls or work on the floor. If we figure on a job where different work is done in any quantity, it is all averaged and the average price taken. A 1 in. coating costs, on the average, about $1.00 per square yard. This average price may be used for rough estimating purposes. For actual practice, of course, the work has to be figured for every job according to the actual conditions.

Q.—What thickness of coating is necessary for steel protection? I refer to exposed work.

A.—As to exposed steel work—for bridges, etc.—I have before me the bulletin of the American Railway Engineering Association for January, 1914, in which a complete report is made by the committee on iron and steel structures for such work. I see from the drawings furnished by Mr. Tebbetts, bridge engineer of the Kansas Terminal Railway, that they apply 3 in. blasts. On a viaduct at Little Rock a 3 in. coating was also applied. I believe that such a heavy coat is not necessary, however; it seems to be the present-day practice to apply 3 in. on such bridges. If steel work is coated, on exposed surfaces in buildings where reinforcement is used 1½ in. to 2 in. should be sufficient; less than 1 in. should not be used in order to have some "body" in the mass. To get rust prevention without reinforcing, a ½-in. coat is all that is required, but there is always a certain amount of vibration, and there being no "body" in a thin coating, it would be more apt to loosen than if a coat with more stiffness in itself were used, with proper reinforcement. I believe 1½ in. is about the least we should apply to such steel work.


Figs. 16 and 17—Coal bunker at Michigan City, Ind., lined with Gunite.

Q.—Would it be possible to use gunite on the old Field Museum building in Jackson Park to restore it, and if so could it be done at a reasonable cost?

A.—There is absolutely no question as to the feasibility of using gunite for the purpose mentioned, and at a cost less than that of any other process. As a matter of fact, the first cement gun was operated on the Field Museum. A light coat of gypsum stucco only was then applied, and at a later time the question was taken up of applying a permanent coating of gunite and transforming the structure into a permanent one.

Q.—The author has referred to the material being put on in coats. I would like to know if it is put on in one layer after another, going over a part and leaving it and then coming back and going over it until a sufficient thickness is obtained. Can you get a uniform thickness over a large surface with nothing except the eye to guide in producing it? Also, about what is the range of the gun at which one works? For instance, if you want to apply gunite to the under surface of a roof or the lower part of a bridge, for instance, a height of twenty or thirty feet, would it be necessary to put up scaffolding for such a distance?

A.—As to the first question, the material is seldom put on in one coating. In work where plain finish is required, it is necessary to go within, say, ¼ in. of the final thickness, then float it over and give the finishing coat afterwards. In bridge work, and work where the outside appearance, or rather the appearance of the work itself, is not of so great importance, the coating is, as a rule, put on in one coat and then a light flash coat is used to even up the very rough places. As to the height to which we shoot, it is desirable to keep the nozzle within three to five feet from the surface to be coated. Therefore, on the under side of the beams which are of a height, say, over eight feet from the ground, it is necessary to build a light scaffold to bring the nozzle within the proper distance from the work.

Q.—I would like to know whether this cement gun process would be applicable to the repair of a corrugated iron roof. The one I have in mind is made of twenty-gauge black iron, painted and badly corroded, and in places it is so badly rusted you can see through it. How thick a coat would be necessary to insure its being practically self-supporting on a three or four-foot span, where the members of the roof would be able to carry a new coating? Have you ever used it for such work?

A.—I am quite sure that the cement gun can repair the roof mentioned, and where the sun shines through and the metal in itself is not sufficient to act as a form, it would be comparatively easy to supply additional reinforcement. I believe that a coat of about 1½ in. to 2 in. thickness (depending upon the slope of the roof, the load applied, and several other things), is all that would be required to put this roof in good condition. It is in just such work that the cement gun is of the greatest advantage, practically such work as requires tearing down by any other process. The ability of the gun to go to most inaccessible places and avoid all this tearing down results in great savings.

Q.—Would there not be danger of the corrugated iron rusting out underneath, making it necessary for complete reinforcement?

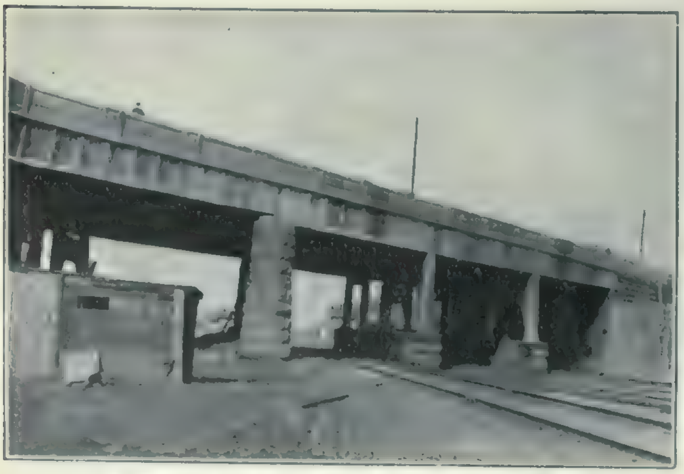


Fig. 18—New South High Street Viaduct, Columbus, Ohio

Fig. 19—Steel work, Woolworth Building, New York.

A.—We would use the corrugated old roof just for a form on which to place our material, providing reinforcing mesh in the new application. The present metal would be simply a form for the concrete work. If it rusts out, no harm is done, and at the same time this rusting could be counteracted to a certain extent by using a light coat, just for rust protection on the under side. This would also give the additional advantage of taking care of the condensation on the under side of the roofing by providing a rough surface.

Q.—How is the gun used on the Panama Canal?

A.—Variable use has been found for it, but the first and rather extensive use was had in the Culebra Cut, where the rock is of a very peculiar formation. There is a hard rock on top with an underlying stratum, which the torrential rains and exposure to atmosphere rapidly deteriorate. As this lower material deteriorated and crumbled down, it would undermine the hard rock lying above. It was found necessary to put some kind of a raincoat, as I might call it, over this mass to protect the material, and that is the first use to which the cement gun was put on the Panama Canal. Before they had a cement gun they used form work and applied ordinary concrete of a thickness of from 4 in. to 4 ft., due to the uneven slopes. With the cement gun, such a levelling was not necessary. There was no attempt made to produce an even surface, but simply to cover this, as it was uniformly 4 in. thick. Later the slides of the Culebra Cut destroyed practically all of this work.

Q.—It would not hold the slide back then?

A.—No, it was not expected to. The gun is also used on the Canal for finishing cement and other work as in ordinary practice.

A. Member:—The following two quotations from the report of the Geologist, appendix e, in the annual report of the Isthmian Canal Commission for 1912, may be of interest as giving the official reason for the lack of success attending the use of the cement gun under conditions for which it was not, as it turned out, particularly suited. Incidentally they may explain to the skeptical, how rock can oxidize.

"The rocks of the cut are mostly basic, and contain iron and magnesia compound in considerable amounts. The iron compounds are largely in the ferrous form and give to the rocks dark and green shades of coloring. On exposure to the moist atmosphere, these ferrous compounds are oxidized to the ferric condition, with change of volume and consequently a crumbling of the material so charged takes place. This, coupled with the soluble character of the limy cement present in varying quantities in most of the beds, seems to be the chief reason for the very rapid weathering here of all except the dense volcanic rocks. It is certain that no practical system of revetment work or retaining walls would prevent the large slides. Still there is no reason why a protecting revetment along the water's edge where the rocks are crumbly, designed to allow for the various adjustments, can not be adopted. A thin veneer of cement spread on the slopes from a cement spraying gun was tried, but without success. Within a few months the thin coat of cement thus put on began to crack and peel off, due to the following causes:

"(1) Oxygenated surface waters seeped through the thin coating and through the rock and oxidized the latter along its contact with the cement, thus causing the adhesive zone or contact to become loose and crumbly and very insecure.

"(2) Irregular swelling of the rock, due to oxidation, adjustment of pressures, etc., cracked the cement veneer and further weakened it.

"(3) Blasting vibrations tended to crack and scale it off."

It will be seen that this explanation applies to the places where the banks are unaffected by the slides. Naturally no one expected this cement coating to resist the pressure of the slides themselves, 4 in. is somewhat thin for a retaining wall for a sliding bank some 200 ft. high.

Q.—Do you lose any cement with the rebound of the sand? How do you try the pressure of the water and the aggregates at the same time? Do you take the city supply, or do you have air pressure behind the water?

A.—As to the first question, the loss of cement is ordinarily a negligible amount; in fact, it is such a small percentage that it does not need to be considered at all. For example, if you take, say, a baseball, or any hard body, roll it in the mud and throw it with very heavy force against a wall, the soft material will leave the ball and splash on to the wall surface. The same takes place on every grain of sand. The impelling force cleans the rebounding sand. Go over our cement work and you find the falling sand at the bottom is perfectly clean. In regard to the second question, it is necessary, of course, to have a higher pressure for the water than for the material. We need about 25 lb. more pressure in the water line than in the material discharge. There are many cases where the pressure in a city water system is 60, 65 and 70 lb.—quite sufficient for cement gun purposes. But if this is not the case, a pump is used in connection with the compressor.

Reinforced Concrete Factory Construction

There are two types of reinforced concrete factory construction—the one with outside bearing walls of concrete and few openings; the other, the skeleton type of construction, the walls being simply filling-in panels, built afterwards. It has been pointed out that the latter is the easier to build and the more economical, but that it calls for a consideration of the following points: The column and pilaster footings only need go down to a solid bearing, unless an excavated basement is required. Where there is a basement, light walls reinforced horizontally from column to column, or vertically from the basement floor to the first floor, will retain the earth, the reactions being taken by the columns or by the basement and the first floor while the walls may be reinforced to carry themselves from footing to footing, requiring no foundation of their own.

Where there is no basement, the outside walls need only go far enough down to prevent frost working in under them, with possibly a shallow trench filled with cinders or gravel underneath. They can be reinforced to carry themselves from pier to pier to support the walls above. By building the footings first, and carefully filling, settling, and levelling the earth and laying the floor on the ground, the shores to support the falsework can be cut of even lengths, and there will be a good, level surface to shore from.

Keeping Reinforcement in Place

THE holding of reinforcing bars in proper position while concrete is being placed, is a matter which merits the utmost attention. The labors of the best designer and detailer can be set at naught by the carelessness of those in charge of the construction of reinforced concrete structures while placing steel and concrete.

A designer spends many days designing and detailing a complicated structure, the strength of which can be greatly impaired by comparatively slight displacement of the reinforcment at critical sections; yet the all-important matter of getting and keeping the bars in correct position is sometimes disposed of by a single note, such as the following: "All reinforcement to be bent and placed as shown on plans, and to be securely fastened or tied to prevent displacement during pouring of concrete and to insure proper position of reinforcement in the finished structure." It is left to the discretion of the construction foreman to devise a means of keeping the bars in position; and, as a result, the strength of the structure may depend on whether the foreman thoroughly understands his business or not.

This is neither good practice nor economy. The method and means of supporting reinforcing bars should be clearly indicated on the plans, since they are as important details as the location of bends of bars and stirrups. Where bars are bent up into the tops of slabs and beams, they are best supported by crossbars resting on concrete blocks of a height to insure the exact location of bars. Bars in the bottoms of slabs can be kept at the proper height by small Z-shaped clips and spacing bars, to which the main bars are wired.

It is just as important to show the supporting bars, supporting blocks and clips, and the spacing bars, as it is to show the main reinforcement in detail. Before the structure can be built, it is necessary for someone to devise a means for keeping bars in position during construction; and as a general rule a good designer is more capable of handling these details to good advantage than anyone else. If it is left to the contractor, the owners pay dearly for this "designing service" rendered by the contractor if he is wide awake; and if he is not, he pays the bill. It can be seen at once that this is neither fair nor economical, and is very likely to lead to "wild" and "unbalanced" bids.

If a contractor is to bid intelligently and all contractors are to enter their bids on the same basis, it is imperative that these details be shown on the plans, when the work is at all complicated or important. The double purpose of keeping the bars in place and having more balanced and uniform bids, is fulfilled at once by including these supporting details.

The Efficient Operation of Water Purification Plants

By H. P. Letton*

SEVERAL interesting papers have recently appeared dealing with the operation of sewage disposal plants and emphasizing the necessity for more careful supervision of this kind of municipal work. It is well known to all who have investigated the matter that small sewage disposal plants receive as a rule little or no attention, and that their effluents could be greatly improved under proper operation. Discussion of these matters is therefore advantageous and desirable.

The writer was for some time previous to last July in the employ of the New Jersey State Board of Health, engaged mainly in the supervision of the public water supplies of the state. In connection with this work about thirty water purification plants have been visited upon numerous occasions. As a result of these visits, it became evident that the opinions that had been expressed in regard to the operation of sewage disposal plants were largely applicable to small water purification plants.

The main difference in the two cases is this: Sewage disposal plants are usually built, not because there is a concerted public demand for them, but for the eradication of a local nuisance, or by order of some higher authority. Because of this fact, and because the terms "sewage" and "sewage disposal" are distasteful to the average layman, the plant is generally put in an out-of-the-way place, and either forgotten entirely or placed in the charge of an underpaid, superannuated caretaker who knows nothing of the principles upon which the design of the plant is based; while a water purification plant is generally installed as a result of a popular demand and the consumer is directly interested in its operation in so far as furnishing a clear, colorless and palatable water is concerned. These are the qualities that to the majority of people determine the purity of the water, and as long as they are maintained there is little or no question as to the efficiency of the plant in other ways. As a matter of fact, however, there are many plants which will usually meet the above conditions but which are inefficient both from an economic and a sanitary standpoint.

It is only on rare occasions that a filtration plant has been constructed at the time of the installation of the waterworks system. In most cases, when the purification plant is added to an existing system, the operation of it is entrusted to the engineer of the old plant. This man may be, and in many cases is, a stationary engineer who thoroughly understands the operation of boilers, engines and pumps but who has absolutely no idea of the principles which underlie the process of water purification.

There is also another point which in many cases affects the results obtained. When it is decided that some form of purification is advisable in connection with a small water plant, it is very rare indeed that a consulting engineer is called in for advice. Instead, the matter is taken up with one or more companies engaged in the business of installing purification apparatus. While these companies are usually competent to give reliable advice, their main business is the selling of equipment. Because of this fact, and because the usual small water company or municipality is weak financially, the filter plant is designed to fit the available money, and the company offering the equipment for the least sum is generally given the contract, regardless of the quality of the material to be furnished. As a result of this practice, plants that are poorly designed, lacking in the necessary equipment for efficiency, or even wholly ill-adapted to the situation are commonly met with. A few cases of this kind which have come under the observation of the writer will be noted.

Inefficient Plants of Poor Design

Probably the worst example was at a plant supplying about a million gallons per day. The supply was originally obtained from artesian wells, but on account of the high iron content of the water a new supply was obtained from an artificial lake. This water was highly colored by its passage through cedar swamps. From the lake the water flowed by gravity to the coagulation basin. This was a rectangular wooden tank of such size that normally less than twenty minutes were allowed for coagulation and sedimentation. During periods of high consumption the time was considerably decreased. The basin was set at such an elevation that at times of low water in the lake it was impossible to obtain the normal supply except by by-passing some raw water. From the coagulation basin the water flowed by gravity to four rapid sand filters of the gravity, circular wooden tank type, without loss-of-head gauges or rate controllers. The agitating rakes were intended to be driven by a water motor, but the necessary power was lacking. The beds were therefore not agitated during washing. From the filters the water passed to a suction well which had been used in connection with the former well supply and which provided less than thirty minutes' storage. Two solution tanks had been provided and connected with a small displacement pump driven from the line shaft to which the main water pumps were attached. The small solution pump was intended to force a solution of sulphate of alumina into the raw water just before it entered the coagulation basin. At the time of the writer's first visit to this plant the chemical pump was out of order and no chemical was being added. It was afterward learned that this was its chronic condition. Tests of the raw water showed it to be slightly acid, owing probably to humic acid from the cedar swamps; consequently the addition of sulphate of alumina would be an absolute loss as far as results are concerned. Analyses of the raw and filtered water showed no material difference, and the filtered water had at times a color as high as two hundred.

While the foregoing may seem to be an extreme case, conditions almost as bad were found in several instances. Two other plants were discovered treating acid water with sulphate of alumina only; rate controllers and loss-of-head gauges were almost unknown; and the methods of regulating the amount of chemical applied were very crude. Few calibrated orifice boxes were found in use. Two gravity, rapid sand plants treating waters high in organic matter and often turbid had no coagulation basins; so that they required too frequent washing with corresponding reductions in bacterial efficiency as well as increased costs of operation. Another large plant, using the pressure type of filter, was treating a turbid water with very little time for coagulation. The effluent was frequently turbid, and at times continued aluminum hydrate. One plant of the slow sand type had less than a foot of filtering sand, and had a clear water well holding about a half hour's supply. As a result of this combination, the rate of filtration fluctuated exactly as the demand, and purification was practically nil.

---

* Sanitary Engineer, U. S. Public Health Service.

At one rapid sand plant the clear water basin was so small that it was necessary to wash with raw water. Another plant had no arrangement for filtering to waste, so that whenever it was necessary to get at the strainer system the dirty water in the bed was drained into the clear water well.

In the matter of operation, conditions were found to be as bad, if not worse. As has been said, the man in charge of a small water purification plant has usually little or no idea of the nature of the process. He operates the plant by "rule of thumb" methods in an endeavor to produce a good-looking water. Although efficient results depend so largely upon the use of the correct quantity of coagulant, the greatest ignorance of this matter was shown. At several plants the engineer stated that he put in a certain number of buckets of alum per day. He did not know how many pounds were used and made no attempt to add it in the same proportion at all times. A few engineers said that they increased the dose "some" when the water was turbid, but did not know how much. In only a few plants was any attempt made to regulate the dosage by the aid of alkalinity tests. At only two plants treating less than twenty million gallons per day were laboratories maintained, and at these plants the tests, both chemical and bacteriological, were made under the direction of non-resident chemists. The engineers who made the tests were unable to interpret them or apply them in the operation of the plants. At one modern municipal plant absolutely no records were kept. The chief engineer could neither read nor write and could see no use in records of any kind, not excepting pumpage records. The president of the board of water commissioners in charge of the plant stated that the only reason he could see for filtering water was to remove turbidity, notwithstanding the fact that the sewage of over a hundred thousand people was discharged into the river from which the supply was taken, about seventeen miles above the intake.

At one plant visited it was found that, through the laziness of the engineer, the filters were not being washed enough, the deficiency of water due to clogging being made up by by-passing raw water. At another plant the beds were washed too often, resulting in a low bacterial efficiency and a high cost of operation. Over ten per cent. of all water filtered was being used for wash water.

The most feasible remedy for poor design is a statute requiring the submission of plans for proposed plants or changes in existing plants to the state board of health or some other state authority for approval before construction can legally be carried out. Such a regulation is in effect in a number of states at the present time. Coupled with the appointment of a properly qualified engineer to pass upon all plans, it will satisfactorily care for new works. State supervision of existing plants will, if carried out, do much to remedy the more serious imperfections of construction and operation. This supervision cannot, however, be thorough enough to furnish definite information for the efficient operation of the plant both from an economic and a sanitary standpoint. At best the plant can be visited only about once a month, and this visit is merely to see that a safe and potable water is being produced. From the viewpoint of the state this result is sufficient, but from that of the consumer and taxpayer there are other matters of great importance. He wishes to know, first, that the water is healthful, and then that it is not possible to obtain the same or better results at a less cost by some change in the method of construction or operation of the plant. This latter is out of the field of the state inspector, for it generally requires much experimenting and testing to obtain the point of maximum efficiency.

The plan of having the engineer at the plant make daily tests under the general direction of a consultant at a distance is a step in advance, but it is far from perfect. The engineer's results are open to question since he is often hurried and makes the tests without knowing the reason for the various steps. Also, since he has but infrequent consultations with the consulting engineer or chemist and is unable in most cases to explain any seeming discrepancy in his results they do not prove to be of as much value as might be expected.

Advantages of a Central Laboratory

The writer has had in mind for some time a plan for remedying this situation, and it has recently again been brought to his attention by a similar plan which Prof. Earle B. Phelps has put into operation in connection with local health administration in several small Massachusetts towns. The plan is simply this: Let several water companies or municipalities, located not too far apart to combine forces, fit up a laboratory at some central point and employ a competent bacteriologist and chemist to give his entire time to the scientific supervision of their water plants. By so doing each plant would have the benefit of expert advice at a small cost. It would be possible for the chemist to visit each plant one or more days each week, and by so doing to become familiar with its operation. He could instruct the engineer in charge of the plant how to make the necessary daily chemical tests, such as alkalinity, turbidity, etc., and since he visited the plant so often these results could be checked up and would be reliable. In case of emergency he would be able to look after the sanitary quality of the water and thus protect the consumer. He would be able to carry on experiments upon the proper amount of coagulants to be used and time of coagulation. There is a chance for much study in the manner of washing the filters to bring about efficiency and economy. This is a point not considered much in small plants, but which has a considerable bearing on the cost of operation. It requires many visits to a plant to become familiar with its operation and to suggest changes which will increase its bacterial efficiency without increasing the cost.

Artesian wells have been discovered in the western portion of Steelton, Ont., and it is reported that 2½-in. pipes have been driven to a depth of 78 ft. and are supplying water estimated to measure 350 gals. a minute, 190 gals. in excess of the town's present consumption. The water is said to be so satisfactory that chlorination will be unnecessary, in which event the town will probably erect a pumping station and stand-pipe to control the supply.

A Process for the Utilization of Sewage Sludge

SEVERAL cities in California have recently had presented to them a proposition by a private company to not only dispose of their garbage without cost, but actually to pay the cities for the garbage delivered at the company's plant, and also to treat the sewage without expense to the city. According to the Municipal Journal, to whom we are indebted for these details, the company in question appears to have financial backing, and expressed its willingness to put itself under bonds to carry out this contract. Such a contract has been made with Los Angeles, and plans for the plant are now under way. A similar proposition was made to a combination of cities, with the idea that they should unite in a common intercepting and outfall sewer which would conduct the sewage to one disposal plant and, we understand, would arrange to have the garbage also all sent to a single plant.

The garbage disposal plant which the company making these propositions—the Pacific Reduction Company—proposes to employ is, we understand, to be modelled largely after the one which has been used successfully by the city of Cleveland for a number of years. More novel is the method by which the company proposes to treat the sewage. The plan in general may be described as follows:

Treatment of Sewage

The sewage passes first through a revolving elevating screen made of wire rope with angle iron separators, by which floating solids and large particles are removed and dumped onto a belt conveyor which carries them to a pulverizer, which redeposits them into the sewage. Provision is made for preventing the escape of odors from this portion of the plant. The sewage is then treated with chemicals (probably lime), and flows into a series of sedimentation tanks which are of sufficient size to give eight hours' retention in the tank and are divided into sections by baffle walls. The object of the baffles is to provide a thorough intermingling of chemical with the sewage and to prevent the formation of surface scum. Some special features are referred to, such as having the sewage, in flowing from the tank, pass over weirs in order to provide for absorption of oxygen from the air; the covering of the building "to protect the sewage from the influence of the sun's rays," etc. The effluent is to be further purified by some process not stated, although the electrolytic process is referred to. The sludge is drawn off from the sedimentation tanks to a pump well, from which a centrifugal pump delivers it to storage tanks. From these tanks it is drawn and forced into filter presses, presumably of the regulation type which have been used for years. During the pressing, steam is supplied for the purpose of releasing the grease, which flows off with the filter water and is collected in skimming tanks, the overflow from the tanks being returned for further treatment.

At this point the real novelty of the plan begins. The sludge is used for making producer gas, the process being described as follows: While the ordinary method of drying sludge has been to drive off the moisture as steam, driving off moisture does not require a temperature of 212 degrees Fahrenheit, but may be secured by subjecting it to large volumes of dry air at much lower temperatures, and much less heat is thus lost up the chimney. "The dryer is of the revolving type and partially enclosed in concrete walls lined with fire brick. Ample areas are provided for the circulation of heated air around the exterior and into the interior of the shell, so that the first value of heat is employed to heat the shell and the second value in heating the air which passes through the dryer in direct contact with the substance drying. The furnace and combustion chamber occupy the lower portion of the enclosed part. An arch extends from the furnace wall to the rear end of the combustion chamber, and the dryer is above the arch. Air inlets are located near the floor of the combustion chamber, and induced draft is developed by power fans, which produces the circulation and discharges the vapors into a condensing chamber. The gases enter the dryer at a temperature ranging between 1,000 and 1,200 degrees Fahrenheit. They follow the course of circulation, mingling and mixing with the air that is supplied to increase the volume, thus utilizing what would otherwise be discharged into the atmosphere. The second application of heat is at low temperatures, as the grease volatilizes at about 490 degrees Fahrenheit, and it can readily be seen how a safe maximum temperature can be maintained by increasing or decreasing the volume of air by controlling the speed of the blower.

"The dry residual matter is deposited by the dryer into a boot of an elevator, which delivers it into storage bins situated above the gas producers." In the condensing chamber referred to, which is connected with the dryer, are baffle walls which cause the gases to pass in a gyratory manner and atomizers which produce a water spray passing downward through the chamber. "The vapors which leave the dryer contain grease, ammonia and carbon dioxide; the heavier are thrown down by a spray, collected and delivered to the storage vats by a pump. The grease is removed and the liquor discharged into the sewage tanks. The light or uncondensed gases are either consumed under the boiler or in the gas producers; or they can be discharged into the atmosphere, as they have been thoroughly cleansed.

"The character of the sludge has undergone a great change by the previous treatment and is converted into fuel, the thermal value being equal to many lignites, tan bark, or sawdust, an ideal material for fuel for a gas producer. The thermal value of sludge was early recognized, but the large percentage of ash prevented its use as fuel for the production of gas. The solution to this problem has been made by the type of gas producers, which are of the revolving hearth type and automatic in action. The mechanism is so designed as to have positive control of the ash discharged. Automatic feed supplies the producer with such amounts of fuel as correspond with the fuel consumption per square foot of grate surface. The gas flows from the producers into the washers, where the impurities are removed, and continues on to the holder." (Part of this gas is used for supplying the heat employed in the dryer.) "The gas washers are of the centrifugal type, known as the Feld washer. These washers have given splendid service in England and Germany, and have been adopted as being the most efficient." Ammonia is recovered as a sulphate at a point between the gas washers and the holder, while the gas is in transit. The ashes from the gas producer are said by the company to form an excellent base for fertilizer.

New Water Supply for Winnipeg

Preliminary work for the new water supply for the City of Winnipeg is going on satisfactorily. The supply is to be obtained from the Lake of the Woods. Advantage has been taken of the frozen ground to make accurate surveys and locate the line approximately on the preliminary alignment through a country almost impenetrable except in winter. A section 37 miles long has been run between two points 38 miles apart, with a deviation of not more than 3 miles from the air line and with a perfectly uniform grade of 0.7 ft. per thousand except for two small river crossings.

The location is through a country about 60 per cent of which is covered with small timber. Half the distance is in muskegs. The concrete aqueduct will be uniformly covered by a fill 4 ft. deep, and it is believed that the invert will at all points be in hard ground below the swampy stratum. A contract of about $1,000,000 has already been awarded for the construction of 96 miles of standard-gage service track for the construction of the pipe line. This track will be built in accordance with standard specifications and will have 60-lb. rail on rock or gravel ballast, qualifying it for permanent service. Construction has already been started on a $15,000 telephone line connecting the engineering and construction camps with the offices in Winnipeg. Mr. James H. Fuertes, of New York City, is the consulting engineer.

New Sewage Disposal Plant in Worcester, England

THE new plant for the bacterial treatment of the sewage of the city of Worcester, England, is now complete. The works have cost, in capital expenditure, quite $500,000; the repayment of loan and interest, covering a period of 30 years, will exceed $30,000 yearly, and the running expenses will amount to $10,000 a year, thus involving a rate of at least 10 pence in the pound. The author of the scheme is T. Caink, the city engineer.

The sewage from the city proper is conveyed under the River Severn by means of a tunnel, at a point where it used to be turned into the stream. That from the suburbs on the western bank, which used to enter the river close to Worcester bridge, is now diverted through meadows to a junction with the deep level sewer connected with the tunnel, and thus the whole of the city sewage is conveyed to the works at Bromwich-lane. After passing through a screening chamber it goes to the detritus well, 84 feet deep, where the heavy inorganic solids fall by gravitation to the mouth of sluice lifts devised by T. Caink which bring them to the surface for disposal. It is then passed to the primary pumps, one delivering 2,000,000 gallons daily and the other 6,000,000 gallons a day, and which is used for lifting storm water when the quantity flowing along the sewers exceeds the capacity of the other pumps.

The primary pumps discharge the sewage into a series of chambers containing gravel disintegrating screens, and thence it is returned to the engine house, where it is raised by secondary pumps into the distributing tower. From the tower it is sent into a series of six rotating sprinklers, of the Candy-Caink type, and distributed over the primary bacterial filters. The latter are six in number, circular in form, 200 feet in diameter and 8 feet deep (of fine gravel). The beds are under-drained by drain pipes and tiles laid radially from the centers to effluent channels which encircle the beds near their circumference. Each filter is surrounded by a number of vertical air shafts, which communicate with the effluent channel. From the channel the air passes along the under-drain, and upwards, taking the reverse course to that followed by the liquid. The sprinklers run upon rails carried upon arched concrete tracks, and are said to be the largest successful self-propelled sprinklers in the world. After passing through the beds the liquid is taken to a series of sand filters 3 feet deep on a layer of gravel a foot deep and is finally discharged into the effluent channel in cascades, which assist, it is believed, in oxygenating it before it flows into the river.

Rerolled Reinforcing Bars Tested

TESTS in the laboratory of Purdue University, Lafayette, Ind., are stated to have proved conclusively that steel reinforcing bars for concrete construction rerolled from old steel rails may be safely used in such work. About 1,000 samples of bars were tested which had been collected from five mills in several States. The samples were taken at different times and under various conditions so as to represent the average output of the mills. The difference between the bars rolled at the several mills was found to be comparatively small. The general tendency shown in these tests was toward a decrease in strength and an increase in the elongation as the size of the bars increased. A part of this general tendency was considered to be due to the fact that a portion of the larger sizes treated were twisted bars. The tests showed that the straight round bar was the strongest and the twisted bar the weakest of the design commonly used. According to Dr. W. K. Hatt, head of the department of civil engineering, under whose direction the tests were conducted, the largest bar which should be used should not be more than 1 in. in diameter. The round bar was found to be more efficient if it had small ribs on the surface, serving to give a better hold in the concrete.

Building an Eighty-Five ft. Chimney in Seven Days

This quite unusual feat was recently accomplished by a St. Louis construction firm. The chimney was built on the company's system of reinforced tile concrete with a reinforced concrete foundation. The company informs us that the chimney was actually built, including its foundation, in seven days' working time and was completed and put in service just 16 days after the receipt of the order. During its construction there occurred, moreover, the heaviest snowfall recorded in ten years in St. Louis, and the temperatures were at no time higher than 20 degrees F. when work was started in the morning. The sand was heated before mixing and the tile was heated before placing. Fires were kept in the chimney constantly with all openings closed. The chimney has a total height of 85 feet and is three feet in inside diameter.

A tunnel under the Danube is planned by the Roumanian Government to form a connection with its newly acquired territory. A bridge was first considered, but as no protected site was to be found, military precautions forced the abandonment of the project. The proposed tunnel will have heavily fortified terminals.

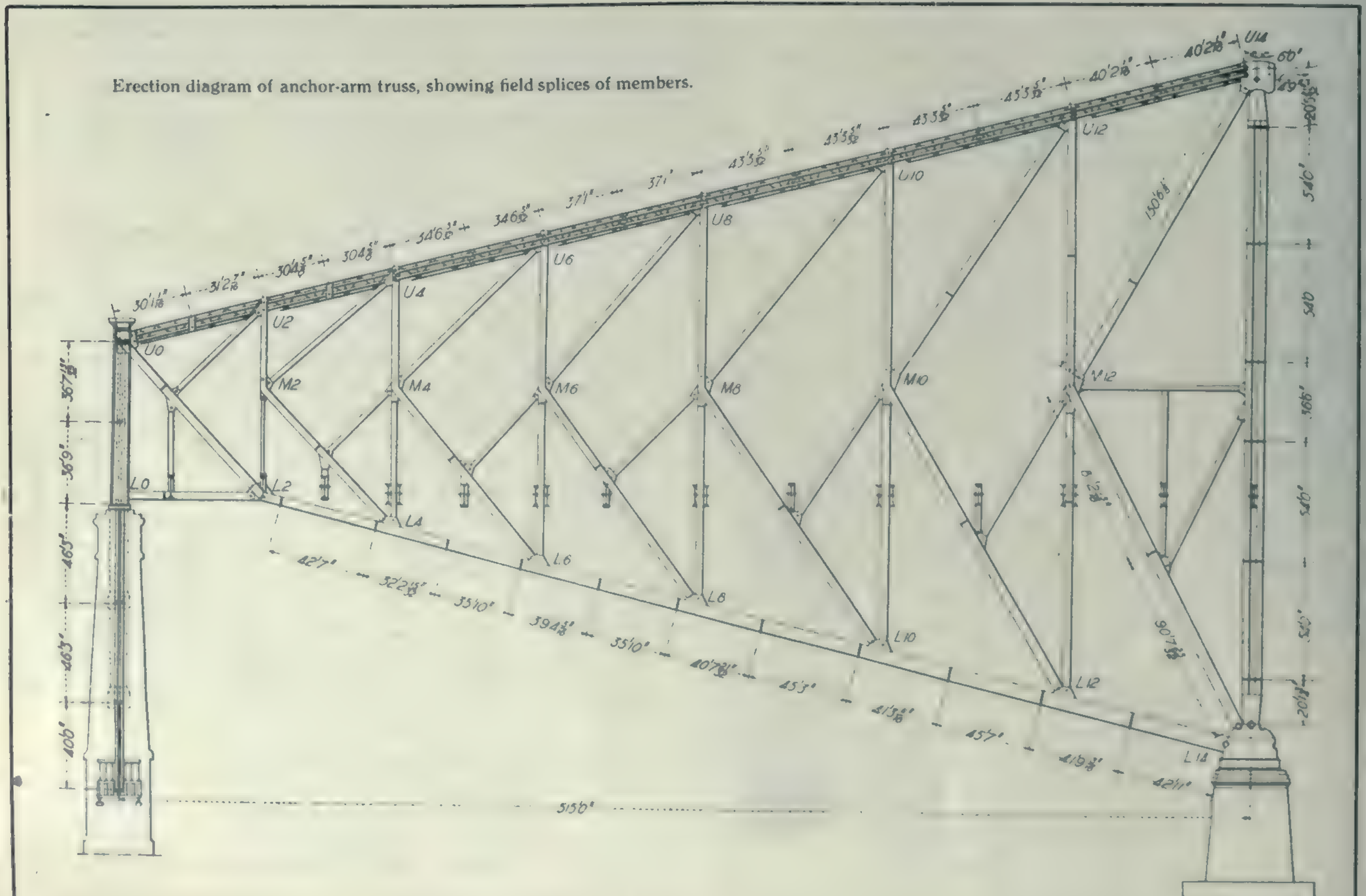
The Quebec Bridge Anchor-Arm Spans

Important Developments in Main Trusses, Bracing, Twin Tension and Compression Members, Multiple-Pin Connections and Field-Spliced Shipping Units

IMPORTANT modifications in both type and details of long-span steel-bridge construction have been developed in the 2,830-ft. double-track Quebec Bridge. Many of them appear in the anchor arms and are described in this article. The type of main-truss bracing is special. The usual top lateral system is eliminated. The extraordinary dimensions and great weight of the truss members necessitate shipping some of them in sections, afterward united by field splices to make the panel units. Auxiliary trusses have been provided to support long flexible members, main panel-point connections have been made with multiple pins, and special connection pieces have been introduced at important panel points. Transverse and longitudinal girders in the floor system have dimensions comparable with large plate-girder spans. Deep transverse latticed traction girders have been introduced between the trusses in diagonal planes.

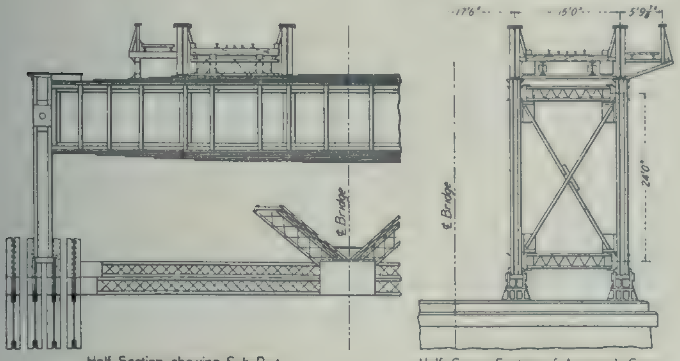
The anchor-arm spans, each 515 ft. long and 310 ft. deep on centers at the main posts, have two pin-connected trusses 88 ft. apart, and weigh 16,600 tons each, exclusive of the steel in the anchor piers, but inclusive of the 2,700-ton main vertical posts and their 900-ton bearings, which are common members in them and in the cantilever arms. The trusses are each proportioned for a live load of two E-60 locomotives followed, preceded or followed and preceded by a train load of 5,000 lb. per linear foot. They are made entirely of carbon steel, with the exception of the end diagonals L_2U_0 and the connection details at L_2 and at U_{14}, which are made of nickel steel.

The web members of the trusses are arranged to make a K-shaped type of bracing, and all carry both dead and live loads, except the horizontal members in the center of the panels adjacent to the main posts on the cantilever side, and the trusses supporting the top-chord eyebars. The chords are in straight lines. None of the principal stresses are indeterminate. The long double-hop-chord eyebars are supported at the center of each panel on special lattice girders connected to the tops of the vertical posts. The 7 x 10-ft. bottom chords are made of four built I-beam ribs laced together, and with horizontal bracing on the center line, the webs being held in place by transverse diaphragms. The principal compression members have intermediate field-riveted transverse splices, and in some of them the sections between these splices are made of two pieces shipped separately. All web members are made up of plates and angles and are pin-connected at their intersections. At the main panel points the web members are connected by pins through gusset plates riveted to the bottom chords.


Erection diagram of anchor-arm truss, showing field splices of members.

independent connections being thus provided for each member.

Some of these features are of special interest in comparison with the 500-ft. anchor-arm spans of the original Quebec Bridge. The trusses of the latter were 315 ft. high and 57 ft. apart and weighed 6,250 tons for each span, exclusive of the 700-ton floor system. Both top and bottom chords were parabolic curves, and the trusses were divided into 100-ft. main panels and 50-ft. sub-panels. The types of truss, secondary bracing systems, top-chord and web-member design and floor system conformed in general to standards for ordinarily long spans. The bottom chords were made of four built channels having their flanges connected by tieplates and lattice angles. They were about 4½ ft. deep and 5½ ft. wide, with a maximum cross-sectional area of 776 sq. in., as compared with a maximum area of 1,902 sq. in. in the present structure. The heaviest chord piece, 65½ ft. long, weighed 165,000 lb.



Half Section showing Sub-Post

Half Cross Section of Approach Span

Part sectional elevations of anchor-arm and end spans.

Secondary Bracing and End Anchorage

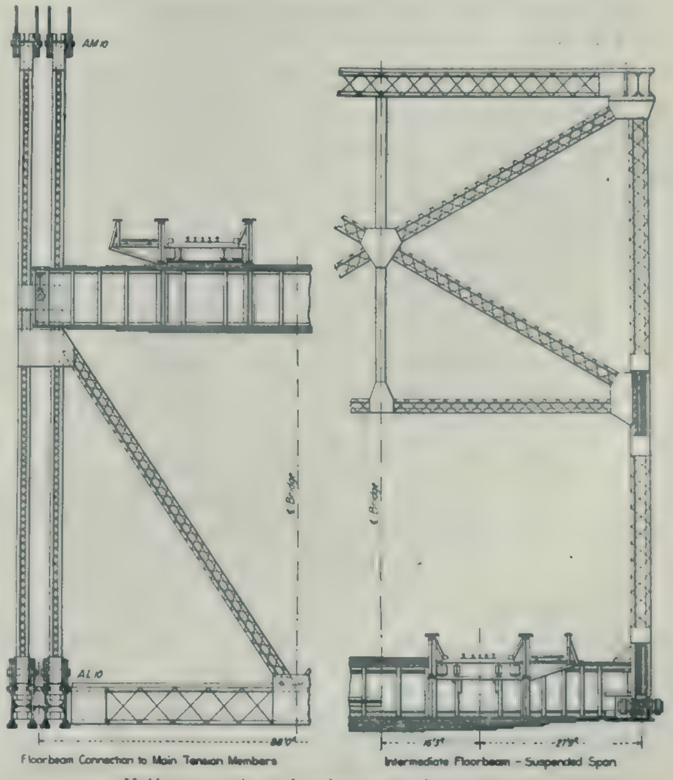
The system of transverse bracing in the anchor and cantilever arms of the present bridge is unusual in that it does not require top laterals. The trusses are connected by transverse sway bracing in the planes of the upper sections of the vertical members and in the lower sections of the inclined members, thus transmitting all transverse stresses directly to the X-braced bottom lateral system in the plane of the lower chords. There are horizontal transverse braces at the top and bottom chord panel points which, like the diagonals and bottom laterals, have rectangular cross-sections made of four large corner angles latticed together with diagonal angles. All of the bottom lateral diagonals are tapered to correspond with the varying depth of the lower chord.

As all floorbeams are located at a considerable height above the bottom chords, the vertical transverse panels under them are braced by diagonal struts reaching from the ends of the floorbeams to the centers of the bottom horizontal transverse struts. The diagonal braces between the upper parts of the vertical posts are connected at their intersections to short vertical members supporting the horizontal transverse struts below them.

The upper part of the masonry in the shore pier, together with the structural steel inclosed in it, is designed to resist a maximum vertical uplift assumed to be 8,000,000 lb. for each truss under extreme conditions. This is provided for by two sets of vertical eyebars connected to the ends of the top chords at U_0. These eyebars have a combined length of about 206 ft. from their connection with the truss to their connection with the reaction girders. Of this distance 89½ ft. are in an open well in the masonry, which, added to 77 ft. from the top of the masonry to the top of the truss, gives a length of 166½ ft. that is free to move longitudinally in accordance with temperature expansion without disturbing the 40-ft. lower section of bars concreted solidly in position. The lower ends of the anchor eyebars are pin-connected to transverse distributing girders, forming part of the reaction platform, built into the lower part of the pier masonry.

The bridge has a clear height of 150 ft. above extreme high water. The floor is level on the center span and has a 1-per cent. grade on the anchor and cantilever arms. The lower chord is level with the floor at the anchor piers and about 110 ft. below it at the river piers. The floorbeams are therefore connected to the trusses in relatively different positions, which govern their type and the manner of connection. At panel points L_1 and L_2, nearest the anchor pier, the floorbeams are field-riveted through connection angles. Floorbeam L_1 supported by a riveted vertical member pin-connected to the end diagonal $U_0 L_2$. Floorbeam L_2 is connected to the lower chord. All other floorbeams are connected to the web members of the trusses by 11-in. pins in 15-in. steel bushings.

At the main panel points 4, 6, 8, 10 and 12 the double floorbeams are made of duplicate girders, one on each side of the vertical hangers, to which they are connected by a common pin. At the main vertical post L_{14}-U_{14} the floorbeam is a single-web girder in the center plane of the post and passes between the duplicate halves of the post, being connected to them by a single pin at each end. The remaining floorbeams at the intermediate panel points 3, 5, 7, 9, 11 and 13 are single-web girders connected to short vertical members from the intersections of the main and sub-diagonals in each panel. At the shore end of the span the floorbeams are located below the intersections of the sub-diagonals and the vertical tension members. At the river end the floorbeams are above their inter-



Floorbeam Connection to Main Tension Members

Intermediate Floorbeam – Suspended Span

Half cross-sections of anchor-arm and centre spans.

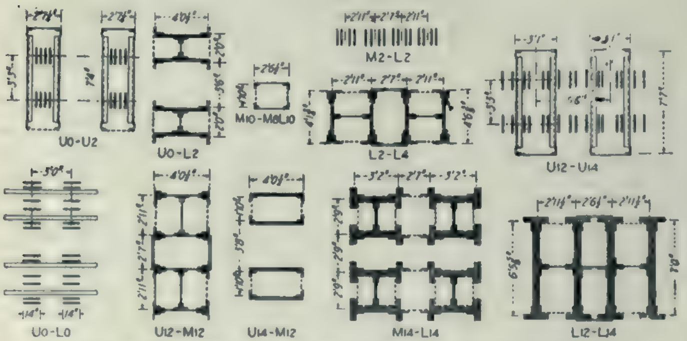
sections and the sub-verticals are compression members with pin connections to the diagonals.

The bridge is designed and constructed subject to the approval of the Board of Engineers, consisting of C. N. Monsarrat, chairman and chief engineer, and Ralph Modjeski and C. C. Schneider. It is being fabricated and erected by the St. Lawrence Bridge Company, Limited, of which Phelps Johnson is president; G. H. Duggan, chief engineer; W. P. Ladd, shop superintendent; G. F. Porter, engineer of construction; S. P. Mitchell, consulting engineer of erection, and W. B. Fortune, erection superintendent.

Important Features of the New Quebec Bridge

The design of the new Quebec Bridge, as was expected, embodies not only a number of important features developed in the largest spans previously built but also some new ones of a radical character. This statement applies to both the main 1,800-ft. span and to the 515-ft. anchor arms.

In the general truss design, the K-shape bracing has important advantages in distributing the shear between two members in each panel, thereby reducing the sizes of the members, simplifying the connections and facilitating field assembling. A decided advantage in erection, too, is found in the very interesting departure of providing separate pins for the connections of different members at main panel points, a feature which, of course, also improves the fabricating details. Shopwork is further facilitated by the use of straight instead of curved chords, with the necessary consequence of right-angle joints in the compression members.



Typical cross-sections of principal anchor-arm truss members.

In the center span and cantilever arms, where weight reduction was important, the selection of nickel-steel for many members was to be expected. In the anchor arm the connection of the vertical anchor bars to the top chords increased the length of the latter, providing better for longitudinal temperature movement, and possibly reducing secondary stresses.

The eye-bar arrangement in the chords is especially worthy on note. The bars, some of which are 85 ft. long, are supported intermediately by special lattice girders. The excessive stresses in the pins, had the usual method been followed, and the difficulty of packing and of assembling the numerous bars in each panel are overcome by placing them in two tiers with double pin connections to the vertical posts.

On account of the part played by the lower-chord design in the previous structure, the section adopted for the new bridge is of special interest. It consists of four deep webs, latticed top and bottom, and having horizontal plate diaphragms on the longitudinal center line.

The secondary stresses and difficult connections, due to the riveted joints at the ends of the enormous single and double-web floorbeams, have been avoided by pin-connecting them to the vertical members. Symmetrical loading is obtained by placing the double webs between the double webs of the hangers. All pins subject to turning have full-length bushings. All transverse forces have been concentrated in the planes of the lower chords by the elimination of the top chord lateral system and by the combination of vertical and inclined sway-braced system transmitting the horizontal forces directly to the bottom-chord panel points.

These and other special features indicate the substantial progress that has been made in this design and suggest the direction in which future advances will be made.

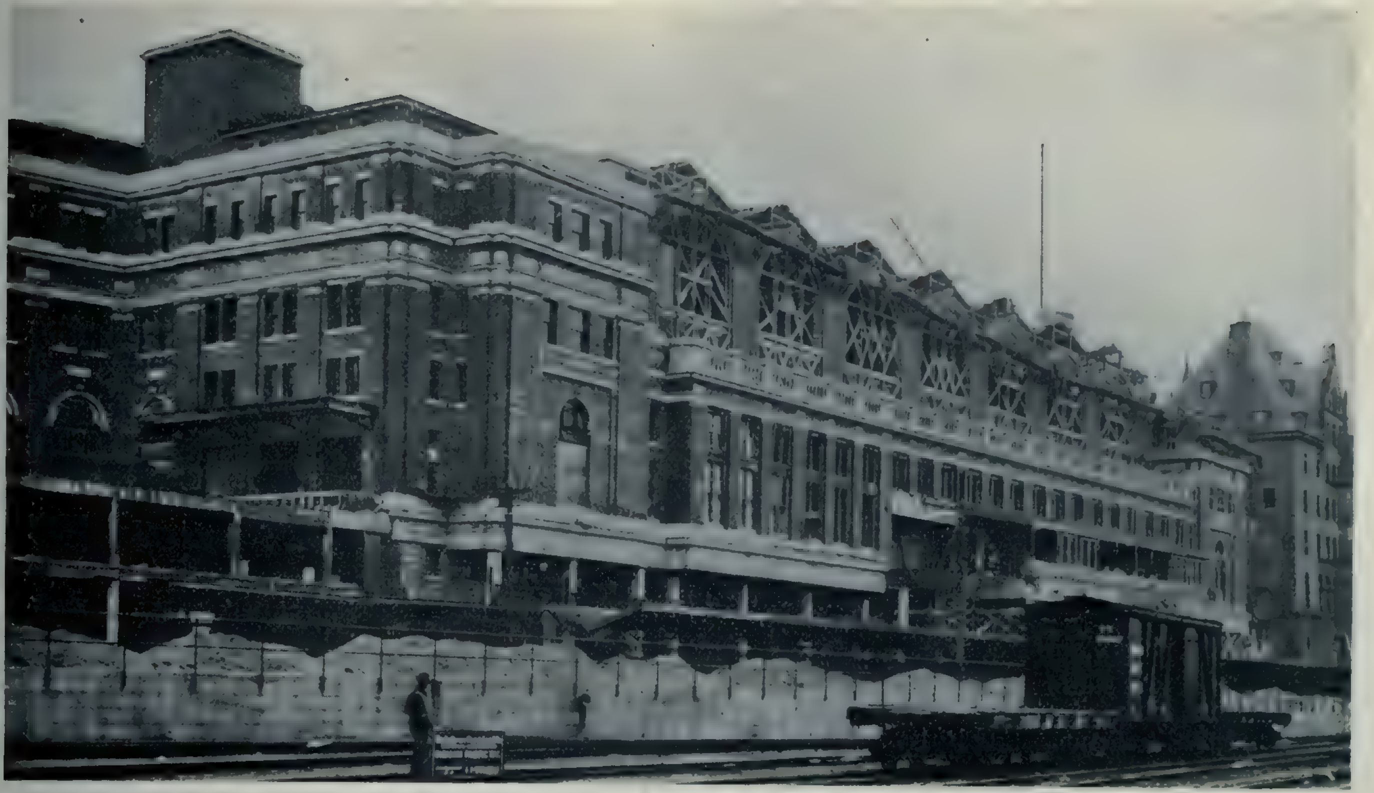
Day Labor and Contract

"Saving the contractor's profit" by carrying out a municipal undertaking by day labor is often an expensive proceeding, comments Engineering and Contracting. A Pacific Coast city projecting extensive harbor developments began deepening the waterway with a municipally operated dredge. The result was unsatisfactory; in fact, it is stated that a good part of the fund was used up before the dredging had scarcely been started. The same city also undertook to construct a bridge by day labor. It is reported that this structure cost $50,000 more than it would if the work had been done by contract. These unfortunate happenings have had one good effect, for the advisory committee in charge of improving the water system has recommended that this improvement be carried out by contract. Experience is a good teacher; so is common sense. By a judicious use of the latter almost any city councilman should be able to see the fallacy of the day labor system of doing public work.

One of the more recent apartment operations in the city of Chicago affords a fair illustration of the way modern builders and architects are treating the housing question. It in reality is four separate buildings occupying an area 150 feet square and will contain 15 apartments of from five to ten rooms, each suite having an individual sun parlor, sleeping porch and a bath attached to every bedroom. The buildings which surround a terraced court centered with a fountain, have an underground tunnel for service and public utility piping. The architecture is in the English Tudor style, the facades being dark red brick with terra cotta trimmings topped by a roof of harmoniously colored slate.

The chief of architecture of the Panama-Pacific International Exposition has approved the design for the Grand Trunk's building, and construction will proceed immediately. This is the first of the Canadian buildings to be erected, and sets the general style for the whole Canadian group. It will contain 10,000 feet of floor space and will be occupied by an extensive and valuable exhibition of Canada's resources. Its location is in one of the best parts of the exposition grounds, and the style of architecture will be that of the Spanish renaissance.

Powder charges used in grading work on the Canadian Northern Railway in British Columbia are said to have given best results when varied from a minimum of ½ lb. of powder per cubic yard of shale to a maximum of 1½ lb. per cubic yard of hardest country rock.



The C. P. R. Terminal Improvements at Vancouver

THE Canadian Pacific Railway Company's terminal improvements at Vancouver, B.C., are rapidly nearing completion. It will be recalled that the general scheme embraced a passenger station and office building located on land immediately east of the present passenger station. Another dock, 200 x 490 ft., has been built. A particular point of interest in this work was the use of piles 135 ft. long on the pier end. The main entrance to the station is located on Cordova street, with the main waiting room on the street level. Tracks are located about 25 ft. below this level and there is provision for four passenger tracks separated by wide platforms. Stairways and lift connect the two levels of the station and a separate footbridge is carried over the passenger tracks and is directly connected with the waiting room at one end and with the stairways leading to the track level, thus giving access to the platforms without crossing the tracks at grade.

In order to avoid a grade crossing and the consequent delays to traffic between the city and the piers a steel viaduct is being built on the line of Granville and Burrard streets, passing over the tracks to the piers. An incline is also being built on the west side of the Granville street viaduct to the wharf, thus giving access to the lower deck of the pier and freight sheds and to the water-front.

The passenger station is a combination stone and brick structure with a steel frame. The station is divided into two principal levels on the lower of which are the baggage, mail and express rooms while on the upper are the ticket offices and waiting rooms. Above the public rooms in the station the space will be devoted to the general offices of the railroad company. The interior arrangement of the office space will be on the unit system and each unit will have complete heating and lighting facilities with partitions that may be readily installed or removed as changes in the arrangement of office accommodations become necessary.

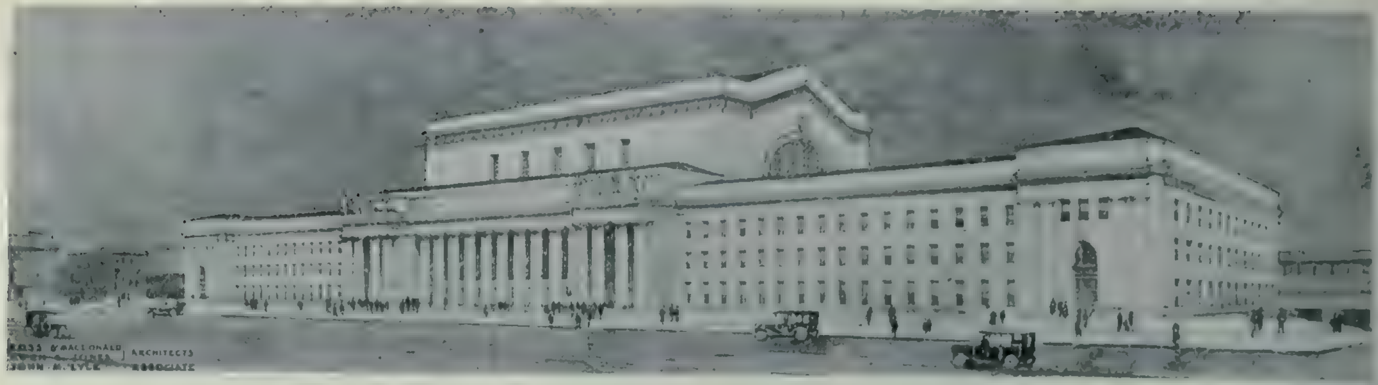
The principal problem was to provide easy and economic communication between the city, the railroad station and the piers, these last introducing an element which is unusual in most railroad terminals so far as passenger traffic is concerned.

It is expected that the station will be ready for occupancy during the summer and that the steamship facilities will be available somewhat earlier, although, owing to the necessity of removing the old station before the viaduct can be built on the extension of Granville street, the use of the present grade crossing over the freight yard tracks will have to be maintained for a month or two longer.

Messrs. Barrett, Blackader & Webster, of Montreal, are the architects for this work. Westinghouse, Church, Kerr & Company, of Montreal, are the engineers for the complete design, construction and equipment of the terminal, working in co-operation with the officials of the Canadian Pacific Railway.

The first Canadian and International Good Roads Congress, to be held in Montreal from May 18 to 23 promises to be one of the most successful in the history of the Association. Several hundred delegates are expected to attend and between forty and fifty of the manufacturers of road-building materials and machinery will exhibit samples of their products in the arena. Speakers of note from several provinces in Canada, the United States and European countries will be present, and the Congress will be officially opened by the Lieutenant-Governor of Quebec, Sir Francis Laugeler. Mr. Lehman, Engineer to the French Government, will deliver a lecture on "Continental Highways."

1914   28(18)



Toronto's Proposed New Union Station

THE Grand Trunk and Canadian Pacific Railways entered into an agreement rather more than a year ago to form a Terminal Company for the purpose of erecting and operating a Union Station at Toronto. The Terminal Company appointed as its Consulting Engineers, Mr. H. R. Safford, Chief Engineer of the Grand Trunk, and Mr. J. M. R. Fairbairn, Assistant Chief Engineer of the Canadian Pacific, with Mr. J. R. W. Ambrose, Engineer of Grade Separation, as Chief Engineer of the Terminal. Messrs. Ross & Macdonald and Hugh G. Jones received the appointment as architects to design and supervise the construction of this work. Subsequently they appointed as their local associate Mr. John M. Lyle, of Toronto.

The architects were instructed by the Board of Engineers of the Terminal Company to study the traffic problem at Toronto in all its aspects and peculiarities, and, without dictation from either Road to design a station which would adequately meet the needs of the passenger traffic of the city and provide for the large growth of traffic indicated by the growth of population of the city and surrounding districts during recent years. They have been working faithfully and continuously on the problem for the past ten months and have collected and tabulated all of the traffic data of the station covering the past twenty years, so far as procurable. They have also made extended inspection trips, visiting all of the larger terminals in America and have obtained from these terminals the amount of traffic being handled by them. This information has all been compiled in tables, which furnish a scientific basis for the design of the new station for Toronto.

The architects' recommendations are contained in an exhaustive report presented to the Engineering Board of the Terminal Company and this report has been thoroughly discussed by the representatives of the two railroads.

This report shows the passenger traffic to be equal to that of Washington, D.C., and to be half that of St. Louis or Kansas City. The baggage business is, however, surprisingly heavy, being equal to that of the Pennsylvania Station, New York, and almost as great as that of St. Louis Station, Boston South Station and Grand Central Station, New York. The parcel business bears nearly the same relation, it being equal to that of the Pennsylvania Station, New York, but is somewhat less than the Grand Central Station, South Station, Boston, Kansas City or St. Louis Stations. The fact is brought out that the average number of pieces of baggage or parcels per passenger is greater at Toronto than at any large station on the continent, so far as records are obtainable.

The character of traffic handled at the St. Louis, Washington and Kansas City Union Stations is similar to that at Toronto. These stations handle a heavy through and local business with heavy maximum periods occurring during certain seasons of the year. The arrangements of these stations and the relation of their present traffic to the areas provided have been very helpful in regard to the requirements for Toronto.

In considering the design of the station, it was found that the average normal traffic at Toronto could be taken care of by a station building of somewhat smaller dimensions than the one proposed, but it is in consideration of the heavy maximum periods such as Exhibition time, June and Christmas holidays, with their attendant crowding and discomfort, which have influenced the architects in recommending the construction of a building large enough to afford a complete separation of entrance and exit traffic during heavy periods and for the time when the traffic of the station has grown to demand it. This principle of the complete separation of traffic and the method proposed for accomplishing it has been accepted by the two roads interested, and is obtained through the utilization of conditions of the site and the relation of track levels to the street. This idea of complete separation of traffic is the dominating one in the design of the station. There has been no station constructed with a similar object in view where it can be so completely accomplished as is contemplated for Toronto and we can therefore recite no parallel case. The Grand Central Station in New York provides separation of express and suburban traffic on two levels, the inbound and outbound express traffic being further separated through the provision of additional separate station buildings. The Pennsylvania Station, New York, provides a separate exit concourse, but the arrangements are such as to make the meeting of friends difficult. The new Kansas City Station provides separation until the Ticket Lobby is reached.

It so happens at Toronto that the elevation of Front Street above the present track level affords an opportunity for placing a Train Waiting Room at a level midway between the street level and the proposed Exit Concourse beneath the Ticket Lobby. This arrangement approximately averages the distances which entrance and exit passengers have to travel and does away with all confusion and crowding and unsatisfactory arrangements for meeting friends, which have been borne by the public in the past. The great advantage to the travelling public will become immediately apparent to anyone who will analyze the operation of the station designed under these conditions. The passengers on entering the station to take trains will enter a large Ticket Lobby approximately 90 ft. wide by 250 ft. long. In this lobby within plain sight are placed all of the general business facilities of the station. In the centre of the room is the Information Bureau; on one of the long sides the Ticket Offices to the number of 20; at one end of the Ticket Lobby is the Restaurant and at the other end the General Waiting Room. Opposite the Ticket Offices are the Parcel Checking Counter and the Baggage Checking Counter, each with a frontage of 50 ft. These are separated by a 40 ft. entrance passage to the Train Waiting Room. Owing to the elevation of the railroad tracks above the street level, this room is placed beneath the tracks. Similar rooms are provided in the new Michigan Central Station at Detroit and the new Union Station at Winnipeg, though these are much smaller than the one proposed for Toronto. The Train Waiting Room is reached by passing down a broad easy ramp in the entrance passage from the Ticket Lobby. As the stairs to trains lead directly out of this room from either side, it will naturally be a gathering place for passengers after they have completed their business in the Ticket Lobby. This room, though limited in height by the elevation of the tracks, will be 100 ft. by 250 ft. and will be made attractive through the use of light colored, durable materials, such as marble and glazed terra cotta.

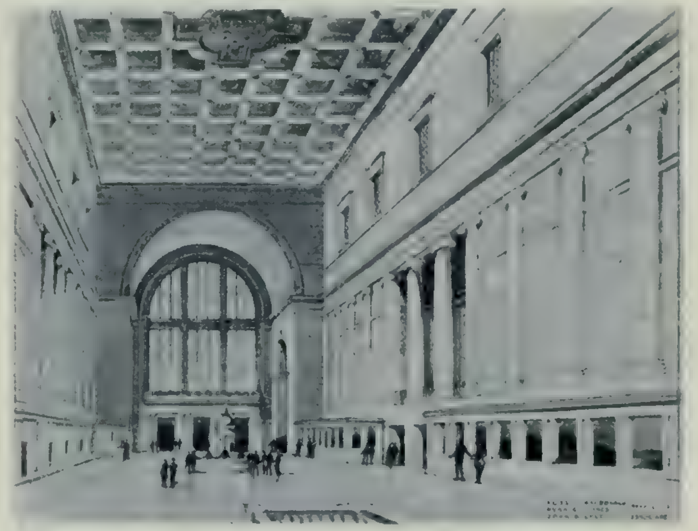
Passengers arriving on trains will descend separate exit stairs leading from the train platforms to separate exit concourses placed each side of and flanking the Train Waiting Room. For passengers who wish to transfer to trains on other tracks, provision is made to pass them through to the Train Waiting Room. Passengers wishing to exit from the station will follow along the exit passages, and during light traffic will pass into the ends of the Ticket Lobby where they may meet their friends, transact their business and exit to the street or to cabs.

The difference in levels between the exit passages and the Ticket Lobby makes possible the provision of easy ramps from the exit passages to an exit concourse placed beneath the Ticket Lobby. During heavy periods exit passengers will pass through this exit concourse, which, except for the Ticket Offices, is practically a duplicate of the Ticket Lobby above, and exit passengers will find all of the facilities required by them within easy access. The Information Counter is in the centre of the room and Parcel Checking and Baggage Claim counters are provided in locations similar to and directly beneath those of the Ticket Lobby. The advantages of this arrangement for passengers are that the business capacity of the station is practically doubled and the transaction of passengers' business will be greatly facilitated through the absence of the interference of entering passengers. In the same manner, passengers hurrying to trains will not be hampered by crowds of exiting passengers wishing to use the facilities of the station. The arrangements for meeting friends are ideal, in that there will be but one point where all passengers can be met, irrespective of the direction from which they arrive. It is expected that checked hand baggage can be delivered to passengers in a much shorter time and passengers having to pass baggage through the Customs will find the Customs offices close at hand. Provision is made for cab service adjoining the exit concourse.

Provisions for handling the enormous baggage and mail business in the station are made in the space beneath the Train Viaduct, with direct communication by elevators to all the train platforms. The building is to be fitted with every modern convenience for the traveller and we believe whether operating under light or heavy traffic, the travelling public will be able to transact its business without congestion or confusion at any time.

The exterior of the building has been designed in an adaptation of Roman classic architecture, and it is the intention to secure a beautiful and dignified effect through the use of plain and simple wall surfaces and the sparing use of ornament, which becomes dingy and dirty in a few years on a building of this character. The interior of the Ticket Lobby will be of similar style to harmonize with the exterior.

The architects and railroad officials have given extended study to all of the conditions entering into the traffic problem of Toronto and the plans prepared will afford real relief to the travelling public and will provide facilities for the traffic for many years to come. We believe that the station when completed and operated as outlined above, should provide the best and most conveniently arranged building of its kind on the Continent. The plans are now being completed and should be ready for the reception of tenders within a few weeks.



Proposed Union Station, Toronto. Main Booking Office.

Ten concrete-road essentials were given by Mr. Ernest McCullough, consulting engineer, of Chicago, in a paper presented at a recent meeting of the Illinois Society of Engineers and Surveyors. These are as follows: (1) Intelligent supervision, (2) careful selection of materials, (3) proper proportioning, (4) proper mixing, using batch mixers only, (5) moderate use of water, (6) avoidance of a mix leaner than 1:2:3, (7) use of reinforcing on wide roads and over filled spots, (8) use of combination metal and fiber expansion joint fillers at intervals of about 25 ft. across the road, (9) avoidance of longitudinal joints, and (10) a visit to some concrete road under construction before attempting to construct one.

The Union Construction Company, North Sydney, N.S., have the contract for a 12-mile stretch of railroad for the Department of Railways and Canals. The contract was obtained for $360,000.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

Owing to the scarcity of work, the painters of Montreal have decided not to strike for higher wages, as they threatened to do.

Oxford County Council is commencing work on a Good Roads scheme in Woodstock, Ont., which will involve an outlay of about $320,000.

The York County Highway Commissioners, for whom Mr. E. A. James, Toronto, is the Engineer, contemplate the expenditure of $150,000 on road work this season. The plans now await government approval.

At a special meeting of Granby Council a resolution was passed in favor of procuring the services of a competent hydraulic engineer to consult with in regard to contemplated improvements in the water supply system.

The first consignment of Pyrites ore to be received this year arrived at Fort William a few days ago over the G. T. P., and consisted of nineteen cars. The Pyrites ore is mined between Fort William and Superior Junction.

The contract has been awarded to Mr. John Putherbough for the erection of a chapel and an addition to a hospital at London, Ont., the contract price being $125,000. The building will be of white brick construction. The architects are Messrs. Watt & Blackwell.

Reports are current that Mr. C. P. McLennan, of Halifax, N.S., is in London, Eng., promoting an English company for the manufacture of railway locomotives at Fort William. The capital of this Anglo-Canadian Company, it is stated, will be £1,000,000, of which £400,000 will shortly be issued in England.

A programme of street improvements for Fort William has been endorsed by the City Council to the extent of about $600,000. Of this amount over $175,0000 will be spent in paving, $84,000 in macadamizing, and the balance on gravelling roads and streets, sewers, sidewalks, and improvements generally.

Burlington Council has been notified by the Government that plans have been prepared for extensive improvements to the harbor. A cement pier will be constructed 150 ft. out, and a breakwater will also be built. The present wooden piers will be replaced by cement cribs sunk to support the new ones.

The contract for the 66,000 volt transmission line, 30 miles long, of the Cedars Rapids, P.Q., Manufacturing and Power Company, has been let. The Canadian Allis-Chalmers, Limited, have secured the order for the steel poles and the Northern Aluminum Company, Shawinigan Falls, will supply the wire.

The contract for section 4A of the new Welland Ship Canal has been awarded to Messrs. MacGuire & Cameron, the contract price being slightly under $84,000. This contract is not in the original lay-out of the canal proper, but is being made to form a connecting link between the old canal and the channel now in course of excavation.

Consequent on the opening up of Longueuil, P.Q., by the erection of the large Armstrong-Whitworth plant, the contract for which was carried out by Mr. E. G. M. Cape, the council have decided to expend $83,000 on improvements. Plans for paving, sidewalks, etc., have been prepared by Mr. A. Ste. Marie, town engineer.

Mr. John E. Conley of Memphis, Tenn., President of the Conley Frog and Switch Works, arrived at the head of the lakes a few days ago to make preparations for the building of a Frog and Switch Plant, situated between Fort William and Port Arthur. Mr. Conley states that work on the construction of the plant will begin almost immediately.

The Interprovincial Brick Company of Canada, Limited, who are erecting a plant for the manufacture of pressed brick near Cheltenham, Ont., have opened head offices in the Goodyear Building, Toronto. Mr. F. B. McFarren, the general manager, was formerly purchasing agent for Mackenzie, Mann & Company, on the Montreal tunnel and terminus contract.

Building permits issued in Fort William since January 1 to the middle of April totalled in value $549,850, of which permits amounting to $118,100 were issued in January; $128,350 in February; $138,750 in March and from April 1 to 23, $164,650. Permits for the two theatres which are to be erected this summer by the Fort William Opera Company have not yet been taken out.

King's County is to have the first Good Roads association in the province of Nova Scotia. The object of the association is to disseminate information regarding the construction and maintenance of good roads, and to increase public interest in road making. Legislative power will be asked for so as to allow of the acceptance of either local or federal aid, or both, for the purpose of demonstrative work.

Writing to the Ontario Board of Works recently Chief Justice Sir William Meredith objected to the policy adopted by the Board in regard to the proposal to turn the effluent from the contemplated North Toronto sewage disposal plant into the Don River. Sir William declares that should the city persist in carrying out its intentions he will appeal to the Attorney-General for proceedings to restrain the city from doing so.

At the annual meeting of the Canadian Club, Mr. E. H. Bennett, the architect who has been chosen by the Dominion Government to prepare plans for the development and beautification of Ottawa and Hull, gave an interesting address in which he traced the progress of city planning from Ancient Rome to the Paris of the 18th Century, and down to the present day. In industrial planning he strongly favored federal districts.

York Highway Commission has been notified by the Ontario Government that road improvement can be proceeded with according to the programme for 1913, an Order-in Council having been passed for the appropriation of $100,000, the understanding being that the city should contribute $100,000, a similar amount to be provided by the Government and the county. There is still about $200,000 available for Good Roads work in Ontario.

Mr. E. G. M. Cape, head of the company which is building the new sugar refinery at St. John, N.B., expects to have the plant running before the end of the present summer.

His company also has the contract for the concrete face and surface of three new wharves at West St. John, these to be finished in time for next winter's business. The timber substructure is being erected by Mr. D. C. Clark, contractor, whose men will work day and night during the next few months.

Mayor Hocken and Works Commissioner Harris have returned to Toronto from Atlanta, Ga., where they had been inspecting a sewage disposal plant of the type which it is proposed to construct in the Don Valley section of Toronto. Mr. Harris announces that the Atlanta system has proved entirely satisfactory. The plant consists of three Imhoff tanks, of which one has been in operation for twenty months, and the people of Atlanta are fully satisfied regarding the success of the Imhoff method.

The Advisory Industrial Committee, Toronto, have passed a vote of confidence in the architects of the new Technical School at present in course of construction, and an expression of perfect satisfaction with the work so far done on the building. The matter arose out of a letter received from the architects, Messrs. Ross & Macdonald, requesting the committee to take definite action to remove existing irritation brought about as the result of charges made by one of the trustees, alleging faulty workmanship against the architects and contractors.

The contracting firm of Edward F. and Gilbert E. Farquier, of Ottawa, obtained judgment a few days ago for $5,315 in an action against Mr. John King, a Fort William contractor. The parties were sub-contractors for the construction of certain sections of the National Transcontinental Railway west of Cochrane, Ont. The plaintiffs claimed from the defendant $8,833 for transportation of supplies, workmen, etc., for their section of the road; also for gravel supplied, hire of freight cars and work done. The defendant set up a counterclaim which was disallowed.

The interesting statement was made a few days ago when passing through Toronto by Mr. W. B. Fitzsimons, Industrial Commissioner of the Grand Trunk Railway, that the large clay manufacturers of the United States are being attracted by the rapid growth of Toronto. He further stated that since the beginning of April he had secured six large clay products corporations which were contemplating the erection of plants in the vicinity of Toronto, and that he anticipated several other manufacturing companies would also open branches in the province before the end of the month.

The year 1913 was a bad one for the building industry and a considerable decrease in the brick business for the year had been anticipated. Those anticipations were realized as far as the National Brick Company of La Prairie, P.Q., were concerned. From the report made at the last annual meeting it was learned that there had been a decrease in the gross earnings of 22 per cent. In his report the President, Mr. J. N. Greenshields, remarked on the fact that although the year opened with a great demand for bricks, subsequent inactivity in the building sphere was reflected in a decline of new designs. The chief factor off-setting the decrease in sales, however, was the high efficiency and low cost of production secured by the company's organization and manufacturing plant. The new Delson plant has exceeded all anticipations with regard to economical production, and the operation of this plant in conjunction with the La Prairie works is said to have resulted in many economies at both places.

A unique building has been erected at Ottawa, and will be used for the purpose of standardizing the Dominion land surveyors' tapes. The building is 18 ft. wide by 150 ft. deep. To obtain the required uniformity regarding weather and temperature five thicknesses of brick were laid in the walls, leaving an inch air space between the sheeting. This sheeting is banked by 18 inches of shavings. Then there is another sheeting of tar paper and 4 inches air space, and a further sheeting, making 4 ft. walls. Another aid to the maintenance of the desired temperature is a system of electric driven fans circulating the air within the building. An idea of the fineness of the work accomplished by the standardization instrument may be gained from the fact that it is possible to measure within one twenty-five thousandth part of an inch. The instrument is so arranged that it works on a series of cement piers, each placed four meters apart, with the exception of those set at a standard distance for testing regulation tapes.

WESTERN CANADA

During the present season, upwards of $1,500,000 will be expended on over a hundred road-making and improving gangs in Saskatchewan.

Work is to start at once on the building of thirty residences, at a cost of about $120,000, at Medicine Hat, Alta. Mr. R. F. Beachey is the architect and general contractor.

Mr. F. S. Cahill, a prominent citizen of Saskatoon, Sask., has offered cash prizes for the most artistic gardens and city blocks. The competition will be handled by the City Parks Board.

A permit has been issued for the erection of an apartment block at Winnipeg to cost $100,000. Mr. H. Genser, of Winnipeg, is the architect and general contractor. The building will be of stone and concrete foundation and brick construction.

An Ottawa syndicate has applied for a 20-year franchise in connection with the proposed street railway system for Prince Albert, Sask., at an estimated cost of $250,000. The syndicate has entered into further negotiations with the city on the subject.

Work has been commenced on the new sewerage system for Esquimalt, B.C., by the contractor, Mr. Hugh Macdonald. The work is being done in sections and the engineer, Mr. C. H. Topp, has plans practically completed for the letting of the contract for another section.

Winnipeg is likely next year to have one of the finest club houses on the North American continent. It will be known as the Winnipeg Athletic Club, and will be fourteen storeys high. With equipment the structure will involve an outlay of $750,000. It is to be ready for occupation in 1915.

Work is in progress on the construction of a business block at Edmonton, on which the sum of $450,000 is to be expended. The structure will be of ten storeys, and of terra cotta and pressed brick construction. Messrs. Olson & Johnson are the general contractors. The architect is Mr. J. K. Daw.

At Calgary, Alta., a storage elevator estimated to cost $1,250,000, is to be erected by the Dominion Government. Tenders for the work will be received by the Secretary of the Department of Public Works, at Ottawa, Mr. R. C. Desrochers, until June 1. Plans and specifications may be seen at the office of the Chief Engineer of Grain Commissioners, at Saskatoon.

Tenders have been called for a new Technical High School, to be erected at Medicine Hat, Alta., at a cost of $300,000. The building will be of brick, stone, fireproof and concrete construction, and bids will be received by the secretary-treasurer, Mr. James L. McCallum, until June 1, for the general contract, particulars of which may be obtained from the architects, Messrs. McCoy & Levine.

Work will start immediately on the construction of a new filtration plant at Edmonton, Alta., on which it is proposed to expend $175,000. The capacity of the plant will be 5,000,000 gal., which with the present clear water basin will be sufficient to meet the requirements of a population of more than a quarter of a million.

Tenders will be called immediately for excavation work in connection with the erection of a new hotel in Victoria, B.C. Plans for the new structure have been revised by Mr. Rexford, architect, which provide for the construction of one substantial main structure, together with a power house, a laundry and an administration hall.

Construction has been started upon a new building at Medicine Hat for a Radiator factory, to be operated by Mr. L. Carey Wright. The contracts have been let for 260,000 brick, 315,000 sq. yds. of roofing and 130,000 ft. of lumber. Mr. Wright considers the prospects very promising for the output of the factory, as nothing of this nature is manufactured in Canada west of Toronto.

The contractors, Messrs. Navin Brothers, expect to have work completed within a month on the new armoury which the Government is erecting at Moose Jaw, Sask., at a cost of $400,000. The building is composed of red brick and white Tyndall stone, with castellated battlements over the main entrance in the centre of the front facade. The front elevation is 234 ft. in length and the depth of the building is 141 ft.

The electric light and power house station at Regina, Sask., which the contractors expect to complete before the autumn, is being built on the north shores of Wascana Lake. When finished it will cost in the neighborhood of $450,000. The new power house will be 218 ft. by 170 ft., covering an area of 28,000 sq. ft., and will be three storeys in height over basement. It will be 68 ft. high and will contain about 800 yds. of structural steel. The building will be of pressed brick and stone construction and the roof of thick concrete and felt. One of the features will be a complete absence of smoke, although the plant will have a battery of sixteen boilers and a generating capacity of 8,000 h.p.

Vernon, B.C., city council has accepted the recommendation of Messrs. Tummins & Agnew, consulting engineers, as to the best methods of bringing Vernon's sewage disposal works up to the requirements of the Provincial Board of Health. One method suggested by the engineers for making the system efficient was to enlarge considerably the disposal works so as to take care of the total flow. The alternative was a lesser addition to the disposal works and the construction of an under-drainage system to carry off the ground water at present seeping into the sewers, and to control the surface water at the same time. The engineers have been instructed to submit detailed plans for the enlargement of the disposal works and the carrying out of the under-drainage system, the work to be done in sections.

Although building operations throughout the west have been somewhat backward this year, there is no want of evidence that Regina will be well in the foreground regarding the extent of the building programme for 1914. Contracts are already in sight which will bring the total up to approximately $5,000,000. This will include the erection of several important public buildings, business blocks, apartment houses and high-class residences, some of which are already under construction. Among the works mapped out for the present season are the Grand Trunk Pacific hotel and station, the ladies' residence, and two towers, at Regina College, the co-operative elevator building, a new power house, police station, provincial jail, armouries and customs buildings for the Dominion Government, nurses' home and wing to General Hospital, new theatre, flour mill and new Government House. Tenders have already been called for the addition to Regina College, which will involve an outlay of about $100,000, while the two towers will cost in the neighborhood of $80,000. Work has been re-started on the G. T. P. hotel and depot, the latest plans for which call for an expenditure of close on $2,000,000. The hotel will be twelve storeys in height, of steel and stone construction, and will be finished in the same style as the Fort Garry Hotel in Winnipeg. There is also an extensive programme in view of civic improvements, such as pavements, waterworks and sewers, light and power extensions and street railway construction.

It is announced that the contract will shortly be let for the construction of the proposed dry dock at Esquimalt, B.C. The dimensions of the dock, the site of which will be the north side of Lang's Cove, will be:—length from caisson stop to head wall, 1,150 ft.; width of entries, 120 ft.; depth on sill at ordinary high-water spring tides, 40 ft.; width at coping of back walls, 144 ft. The section near the entries measures 500 ft. in length and the one further east 650 ft. By this arrangement there are virtually two docks in which small ships can be conveniently handled, either in couples or singly. Each part will be closed by steel caissons. The dock will be emptied by three centrifugal pumps, each having a capacity of 60,000 gal. per minute. The pumps and other machinery will be operated by electric power generated by the dock power plant. After the rock excavation the construction of the walls will be commenced. These will be built of concrete, with granite copings and alters. All keel and bilge blocks will rest on granite strips extending the full length of the dock, and granite will be used for caisson stops. On the south side a basin will be formed to allow of repairs while vessels are afloat, and to unload cargoes from vessels before entering. The structure round the basin will be built of reinforced concrete piles, and reinforced concrete will be the material used on the construction of the extensive frontage of wharves. The Dominion Government appropriation of 1914-15 will be available for the work, which when completed will be one of the finest undertakings in Canada.

Canadian Railroad Development

Construction has been resumed on the Lake Erie and Northern Railway, and operations will be continued as far as Brantford.

As a result of a protest from the Ontario and Dominion Sewer Pipe Companies against a rate of 2 cents per 100 lbs on the carriage of clay between Waterdown, Mimico and Swansea, the Dominion Railway Commissioners have reduced the rate to 1½ cents per 100 lbs.

The heavy grades on the Intercolonial Railroad between Sydney, N.S., and Moncton, N.B., are to be eliminated subject to the approval of the Minister of Railways. This reduction of grade would mean a saving of 25 per cent. in operating expenses, and the company contend that the tonnage as a result of the change could be doubled by increasing the strength of the approaches.

With the completion of the Grand Trunk Pacific branch now under construction from Regina to Northgate, the port of entry on the international boundary, it will be possible for passengers to board a train at Chicago and proceed without interruption to Prince Rupert. By completion of the branch to Northgate the G. T. P. will be given an entrance to St. Paul over the Great Northern tracks.

The Dominion Railway Commissioners have been approached by Mr. M. K. Cowan, K.C., on behalf of the Milton Pressed Brick Company, who complained that the C. P. R. had failed to lay the tracks as anticipated by the Brick Company when double-tracking the line between Guelph Junction and Toronto. The Brick Company applied to have the tracks removed to enable them to increase the yard area, but this the Railway Board declined to accede to.

A report from Edmonton states that more than $10,000,000 will be expended by the C. N. R. on construction work in Alberta during 1914. The Onaway North-West line to Pine River Pass, which is guaranteed for one hundred miles at $20,000 a mile, is well advanced, thirty-two miles of steel having been laid and the remainder of the work will be completed this year. The government is stated to have insisted on the construction this year of the line from Little Bow, south of Calgary, to Macleod which road is guaranteed at $15,000 a mile.

A deputation from Northern Ontario waited on the Provincial Government a few days ago with the object of urging the construction of the Elk Lake branch of the Temiskaming & Northern Ontario Railway from its present terminus to Gowganda and thence to Sudbury. Replying on behalf of the government, Hon. W. H. Hearst stated that he was unable to promise how soon the line would be constructed. For some time the government, through the railroad company, had been investigating the possibilities of the district and endeavoring to find a location that would be practicable both as an engineering and a commercial proposition.

The new section of the Lacombe and Blind-man Valley Railway from Lacombe to ten miles west of Gull Lake, Alta., is expected to be opened for traffic on July 15. This railway is the first to secure assistance in accordance with the recent legislation by which the province guarantees the bonds of lines building into territories not already opened up by steam roads. Other companies are said to be anxious to take advantage of the new law, and extensive building of light railways in Alberta is looked for in the near future. The total length of the new line will be about thirty miles. The road is being built of standard gauge with steel sufficiently heavy for large locomotives.

Messrs. Armstrong & Morrison, of Vancouver, have commenced the driving of piles at Pitt River and will shortly move the section of the old steel spans from the present railroad bridge in preparation for the construction of the new double-track traffic bridge across that waterway. Steel work on the new bridge commenced some weeks ago, the contractors for the work being the Dominion Bridge Company. The piers for the structure are now completed. The steel trusses will be placed west of the draw span, and the draw itself will be of the usual swing pattern. The superintendent of the Dominion Bridge Company, Mr. J. Findlay, expects to have the work completed next October.

Several Montreal architects have removed to new addresses, as under: Brown & Vallance, Southam Building, Bleury Street; Saxe & Archibald, Royal Bank Chambers, Dorchester Street and Beaver Hall Hill; Nobbs & Hyde, Old Birks Building; Doucet & Morissette, Dandurand Building, St. Catherine and St. Denis Streets; and Benoit & Girard, Southam Building.

The Asphalt & Supply Company, Limited, Montreal, have removed to 107-108 Board of Trade Building, Montreal.

In order to secure increased facilities for their business, Messrs. Archibald and Brotherhood have removed from the Herald Building to the Southam Building, 128 Bleury Street, Montreal.

Mr. P. A. N. Suerot read a paper on Subaqueous Tunnelling at a general meeting of the Canadian Society of Civil Engineers on the 23rd ult. The paper is a compendium of interesting facts about this class of engineering and of observations recorded by the writer while engaged on the construction of important subaqueous tunnels in America and Europe.

Personal Mention

Mr. G. H. Archibald, of St. Catharines, has been appointed City Engineer of Saskatoon.

Mr. George Hogarth, Assistant Engineer, Department of Public Works, Ontario, has also been elected a member of this body.

Mr. James C. Morton has accepted a position as superintendent of the National Paving & Contracting Company's Regina branch.

Mr. J. W. Evans has been appointed City Engineer of Belleville. Mr. Evans is president of the Tivani Steel Company, Belleville.

Mr. George W. Lee has been selected to succeed Mr. Fred Dane on the Temiskaming & Northern Ontario Railway Commission.

Mr. F. A. Dallyn, C.E., provincial sanitary engineer of Ontario, has been elected to membership in the American Waterworks Association.

Mr. E. I. Sifton, consulting hydro-electric engineer, of Hamilton, Ont., has been appointed manager of the hydro-electric plant of Hamilton.

Mr. James L. Dusfield, of the firm of Mackenzie, Mann & Company, of Montreal, has been elected an associate member of the Institution of Civil Engineers.

Mr. J. A. Wickett, Toronto, died April 26 following an attack of heart failure. He was a well-known masonry contractor, and was born in Belleville in 1858.

The death took place recently of Mr. Geo. H. Waring, President and Managing-Director for many years of the Union Foundry & Machine Works, Limited, of St. John, N.B.

Mr. C. C. Mendham, who has been connected with the outdoor staff in Toronto of the Herbert Morris Crane & Hoist Company, Limited, has now been appointed Resident Engineer in Berlin for the same company.

Mr. M. H. Baker, formerly city engineer of Prince Albert, Sask., is at present associated with the Surveys Branch Department of the Interior on the survey of roads and townsites in the Rocky Mountains near Banff.

Mr. Robert C. Muir has been appointed to the staff of Mr. W. A. MacLean, Provincial Highways Engineer for the Ontario Department of Public Works. Mr. Muir until recently was associated with the firm of Mackenzie, Mann & Company.

Mr. S. B. Wass, chief engineer of the Quebec Extension Railroad, has been appointed Assistant chief engineer of the St. John's (Quebec) Railway, a proposed line 174 miles long and extending from Quebec Province to the State of Maine.

Mr. Alexander Allaire, Western Manager of the Foundation Company, Limited, Vancouver, was elected to membership of the American Society of Civil Engineers recently. Mr. W. F. Hicks, superintendent of Operation and Maintenance Department of Natural Resources, C. P. R., Lethbridge, Alta., has been elected to Associate Membership of the same body.

Canadian and International Good Roads Congress—Montreal, May 18-23, 1914.

Golden-Anderson Patent Cushioned Controlling Altitude Valve

A valve which should meet with favor where conditions are such that the amount of water in a water tank is automatically regulated, especially in regions where the regulator is liable to freeze, is the Golden-Anderson Patent Cushioned Controlling Altitude Valve which is designed to operate under varying pressures. If the valve is placed in a pit under the tank, or any conveniently accessible place, and is protected from freezing weather, it insures a water supply at all times.

The illustration shows the main valve closed. The operation is as follows: With the main valve closed, if water is drawn from the tank, standpipe or reservoir, the pressure is removed from the top of the diaphragm "R," causing the valve-spindle "K" to rise, which allows the high-pressure auxiliary valve "H" to close and the exhaust valve "I" to open, permitting the water above the piston or valve "B" to escape through "M" and "N." As the pressure above the valve is removed, the pressure under the valve "B" forces it open. The water above the valve acts as a cushion in opening, and, at the same time, as the valve begins to travel upward it draws air in through the port "F," in the side of the body, to cushion the valve when closing.

The water in the tank having reached a predetermined height, the pressure entering through the small pipe "T" is distributed on the top of the diaphragm "R" causing the valve spindle "K" to close the auxiliary valve "H," thus allowing the pressure to come on top of the valve "B" through the ports "L" and "M." Owing to the greater area being on top of the valve "B," it is forced to its seat, thereby shutting off all water. This action of the main valve "B" brings the air cushion into operation, compressing the air and forcing it out through the port "F," thus preventing shock in closing.

The Altitude valves will work both ways, maintaining the water level in tanks, standpipes or reservoirs, on a single supply and discharge line, and allow the water to flow back through the valves for distribution whenever the pressure is less on the inlet side of the Altitude valve.

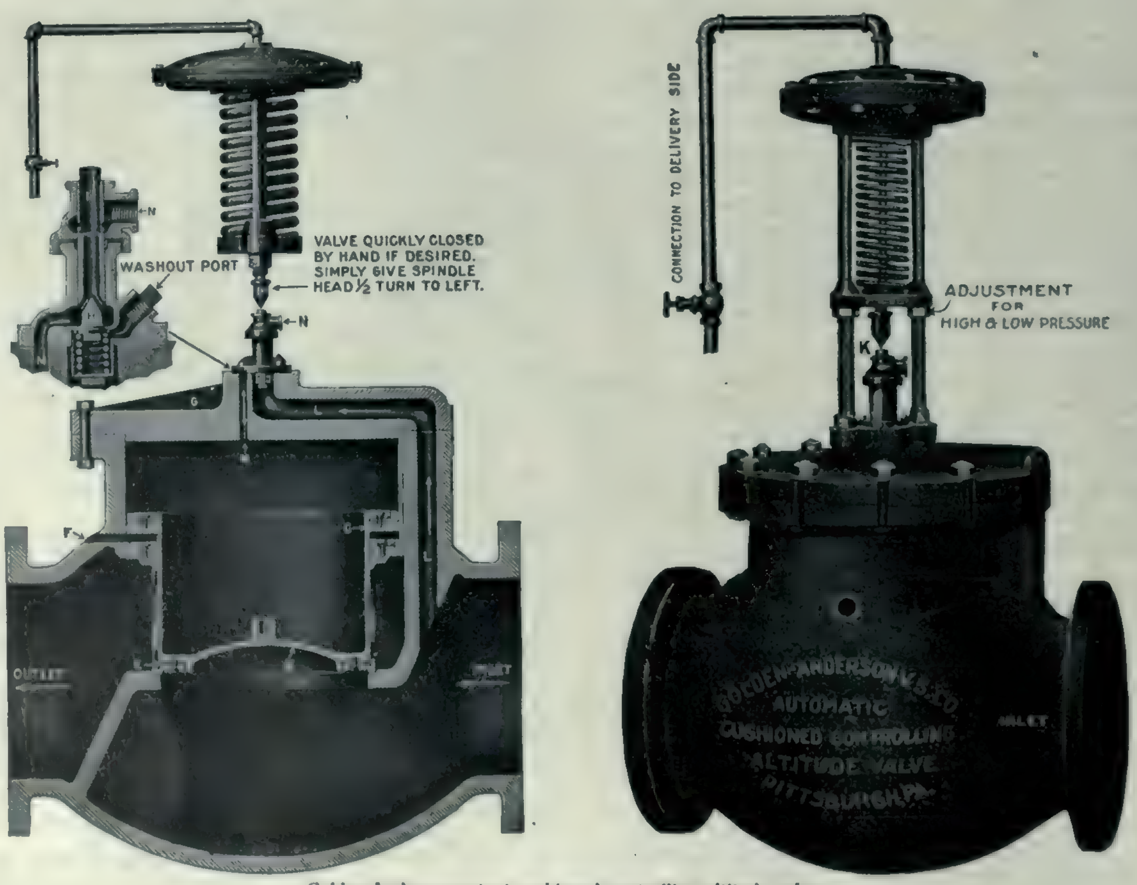
The valves are so constructed that electrical appliances can be attached quickly, so that the valve can be closed at any time by throwing an electric switch in contact at the pumping station or as many different places as desired. By using this valve so arranged there are two ways of closing, viz., by water and electricity. This is especially important in case of fire.

The Montreal Builders' Exchange have removed from the Eastern Townships Bank Building to the Victoria Building, Victoria Square.

Messrs. Chadwick & Beckett, architects, Toronto, have removed their office from 18 Toronto Street to more commodious quarters over the new Bank of Nova Scotia Building, 130 Church Street.

Mr. W. G. Hunt, architect, formerly of 935 Bloor Street West, Toronto, has opened offices at 244 Confederation Life Building, and has taken into partnership Mr. A. H. Woodburn, late of the City Architect's Department.

A pamphlet devoted to steam and power pumps manufactured by the Gray Manufacturing and Machine Company, Limited, Toronto, is illuminating as to the advanced design and high grade workmanship. The publication is bulletin No. 12, and communications respecting it should be addressed to the firm at 686-692 St. Clarens Avenue.


WASHOUT PORT
N
VALVE QUICKLY CLOSED BY HAND IF DESIRED. SIMPLY GIVE SPINDLE HEAD ½ TURN TO LEFT.
N
F
OUTLET
INLET
CONNECTION TO DELIVERY SIDE
ADJUSTMENT FOR HIGH & LOW PRESSURE
K
GOLDEN-ANDERSON V.S.CO.
AUTOMATIC
CUSHIONED CONTROLLING
ALTITUDE VALVE
PITTSBURGH, PA.
INLET

Golden-Anderson patent cushioned controlling altitude valves.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.

HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **May 13, 1914** **No. 19**

Principal Contents

The Layman and Sewage Disposal 567-8
Canadian Constructional Centres, Part 1 569-79
The Evolution of Sewage Disposal Methods in Canada. 580-6
By T. Aird Murray
The Meter System as a Preventive of Water Waste.. 586-7
By Herbert J. Bowman
Extensions to Hamilton Waterworks 588-91
By W. Hollingworth
Macadam Road Maintenance 592-4
By E. A. James
Brick Pavements—Their Maintenance and Repairs ... 594-6
By F. F. Townsend
Low Level Bridges at Edmonton 596-8
By H. F. Christie
Design and Value of Sedimentation Basins 598-600
By Alexander Potter
Depreciation in Relation to Municipal Works 601-3
By R. O. Wynne-Roberts
Caisson Type of Infiltration Reservoir, Sarnia, Ont., Waterworks 603-5
By H. A. McLean
A Retrospect of Municipal Engineering 606-12
Engineering Activities of the Department of Marine and Fisheries 612-4
By Lt.-Col. Anderson
Foundations of the Dam across the North Saskatchewan River at LaColle Falls 615-9
By F. A. Creighton
Recent Developments in Concrete Arch Bridges in Canada 620-3
By Frank Barber
Steel Structure, Dominion Bank Building, Toronto .. 623-5
Present Status of the Marble Industry in Canada 626-9
By Dr. W. A. Parks
Waterproofing—History and Development of 630-1
By W. H. Evans
Road Congress, Montreal 632
Constructional, Personal and Industrial News 633-6

The Constructional Development of Canadian Towns and Cities

ONE of the outstanding features of this number is the First Part of an Alphabetical Reference to practically every town and city of any importance in the Dominion. It is hoped that this reference will be found a useful compendium of constructional data, and readers of this journal are cordially invited to make application to us for such further information as may be available and which, in cases, may have been withheld owing to considerations of space.

It may be well to emphasize the point that the particulars given are in all cases authoritative, the details having been furnished directly by the municipal officials—generally the City Engineer in collaboration with the City Clerk. Returns have been received from some one hundred and seventy municipalities, of which some seventy are published in Part 1 in this issue. It is hoped to conclude the feature in the issues of May 20 and May 27.

In a general way, the development of the various municipalities during the quinquennial period from 1909 to date is shown, the figures being followed by estimates of constructional work for 1914 and by statements concerning roadway, sewerage, garbage and water supply systems.

We believe that the data given will enable our readers to make many useful deductions and comparisons as their requirements may suggest.

In the compilation of this work we have been greatly indebted to the city engineers and city clerks, to whom, collectively, we tender our best thanks, and we must also acknowledge the supplementary work on this feature contributed by the correspondents of this journal in various centres. The spirit of co-operation shown in this undertaking has been particularly gratifying.

Redundancy is an offence which we do not condone as a rule, but in this instance we make no apology for repeating the invitation contained in the foreword. The Contract Record is essentially a service journal and it is hoped that the reader will not hesitate to avail himself of any additional assistance we may be able to afford him.

The Layman and Sewage Disposal

EFFICIENT sewage disposal, carried out on the most improved methods known, free from odors and nuisance of any kind, and providing no objectionable features in the neighborhood where the works are constructed, is essentially in demand in Canada at the present time.

Last year the city of Toronto put into operation a sewage disposal plant which cost in the neighborhood of half a million dollars. This plant consists of a series of one-compartment sedimentation tanks. Its purpose is to extract the solids from the sewage, the solids being conveyed to Ashbridge's Bay. The liquid sewage is not treated but is allowed to empty into Lake Ontario by means of a long iron syphon pipe.

Since the works have been in operation, deputation after deputation from the neighborhood has made representations to the city council, complaining of the foul odors in the neighborhood.

Before the works were constructed, an American and a British expert were called in by the city to pronounce upon the plans, which were the design of the

City Works Department. These experts stated, "No nuisance will arise from the tanks if they are properly constructed and operated, but as an extra safeguard provision will be made to ventilate them by means of an electrically-driven fan fitted with a suitable exhaust pipe." This simply meant that if foul odors did arise, they would be driven forth into the atmosphere by fans. This appears to be what has happened, with the result that habitation within half a mile of the works has become almost unbearable.

It now appears that the whole tank system just completed is wrong in principle and is fit only to be scrapped. In fact, all that Toronto has obtained from its expert advice appears to be represented by a series of old-fashioned septic tanks which have been superseded by improved construction since 1908. In 1908 the septic tank was pronounced a failure by the British Royal Commission on Sewage Disposal. At the time of the proposed installation of the Toronto works, much criticism was offered by other engineers and by the local press, but the certificate of efficiency given by the two outside experts satisfied the city council and killed public criticism for the time being.

Now the question is: what lesson can municipalities learn from Toronto's failure to obtain efficient sewage disposal works?

The municipal council of Toronto have lately shown evidence that before spending any further sum on new works they will learn for themselves just what can be done in the way of obtaining satisfactory results without creating a local nuisance. Just why they did not do so before is a puzzle. Criticism of the proposed scheme was offered freely at the time. Did the council attempt to find out for themselves whether this criticism amounted to anything? Evidently they did not do their whole duty as they now conceive it, or else why this sudden determination to find out for themselves as business men and judge of results from practical showings?

First we find the Toronto council send their Mayor and Commissioner of Works (who is not an engineer) to Georgia to examine a new sewage disposal plant, the principle of which is not the septic tank but a tank built on modern principles. Is this the nearest or the only sewage disposal plant on modern principles located on the American continent? Not by any means, according to an article contributed to this issue by Mr. T. Aird Murray. We think that the city of Toronto can learn everything that it is necessary to learn with reference to sewage disposal by staying in Canada and studying the question at home where there are plants in existence built and designed to suit our Canadian winter conditions and which are giving really efficient results.

Secondly we find the city council in a panic—not content to take the report of their Mayor and Commissioner, but resolved to travel in a body to Georgia to find out for themselves if a sewage disposal scheme can be installed without odors or nuisance. And then, thirdly, we find them influenced by the satire of the press—rescinding their resolution and resolving to divide themselves into parties and be personally conducted over various plants on the American continent.

Now we do not grumble at this thirst for exact information which has suddenly seized the members of the Toronto city council, although it might have been in the interests of the city had they discovered the thirst sooner, but there are limitations to the amount of exact information which a body of laymen can obtain on a difficult chemical and engineering matter.

Sewage disposal is not represented by any one defined appliance or complete machine, and we must endorse the conclusion at which Mr. Murray arrives in the article to which we have referred, viz., that there is no one system of sewage disposal which can simply be repeated to meet any local condition. In this, all authorities of any note, such as the Local Government Board of England and the Massachusetts Experiment Station at Lawrence, are agreed.

Hence, there is just the trouble that any deputation of laymen—or even of engineers not experienced in this particular class of work—viewing a plant working efficiently under certain defined climatic and other conditions relating to the character of the particular sewage under treatment, may come to the conclusion that this is just the system they want.

It is well and proper that municipal representatives should make themselves thoroughly acquainted with the matters on which they are called to vote public money. No ratepayer can grumble at expense for such purpose. But is it not time that sensible men at the head of affairs in Canada should recognize that this country has a problem of sewage disposal of its own? We have to contend with climatic conditions which are not exactly similar in either Great Britain or the United States. We have certain conditions relating to our water supply from the Great Lakes—a subject which receives careful treatment in Mr. Murray's article. We have engineers in our midst who, for many years, have been studying Canadian conditions relative to sewage disposal. We have several plants in operation in Canada which are giving efficient results and which are, we think, in accordance with modern ideas.

If we were called upon to make any suggestion of a practical character, we would say that the city of Toronto would do well to form a commission consisting partly of its own representatives and partly of scientific men who have studied this question in relation to Canadian conditions, with power to examine into schemes now operating in Canada and to decide as to what particular scheme would fill the bill in Toronto. There is sufficient evidence in Canada itself to allow of an exact determination being made with reference to a final and complete system of sewage disposal for Toronto without the trouble and expense of visits to southern states where the conditions are entirely different from our own.

It is interesting to note that water-front development will form the theme of special discussion at the International Conference on City Planning which is to be held in Toronto, May 25-27. The works now in progress at Toronto should prove of national importance as an example of what may be done by systematic planning for water-front development. The entire harbor project at Toronto will take until 1920 to complete, and will cost upwards of $19,000,000.

Canadian and International Good Roads Congress, Montreal, May 18-23, 1914.

Read the editorial announcement regarding this meeting published elsewhere in this issue.

Canadian Constructional Centres

A Compendium of Engineering and General Progress Data Relating to the Activities of the Principal Towns and Cities of the Dominion. Arranged Alphabetically by Provinces.

PART I.

Newfoundland, Nova Scotia, P.E.I., New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia

WE inaugurate in this issue an **Alphabetical Reference to the Towns and Cities of the Dominion.** This reference consists of a compendium of constructional data calculated to be suggestive and informative to the engineer, the architect and the contractor. In the case of each town and city an attempt has been made to provide sufficient particulars to furnish the reader with some estimate of recent development, to give him some idea of the value, resources and equipment of the municipality, and to enable him to size up the possibilities identified with the programme of expansion for 1914. For obvious reasons this has not been possible of fulfilment in the smaller towns, but the idea has been carried out with considerable success in the case of the larger centres.

As explained in the editorial reference to this feature made on another page, every effort has been put forth to ensure the authenticity of the particulars given. The information has been prepared by municipal officials, and most of the data have been officially revised within the last month, so that the objection to most information of a statistical or semi-statistical nature, viz., that it is "stale" by the time it is printed, cannot be sustained in this case.

Returns have been received from some one hundred and seventy municipalities, a figure which represents nearly ninety per cent. of those to whom application was made—a gratifying result. The particulars asked for included comparative population and assessment figures, comparative returns of building and engineering work, and details as to roadway, sewerage, garbage, water supply and electric light systems. The engineers were requested to furnish information as to the mileage and classification of roadways; as to the sewerage system and the method of disposal; as to the collection and disposal of garbage, as to the source and description of water supply—and so on.

ELECTRIC LIGHT SYSTEMS

The publication of complete statistical information on the various electric light systems scarcely falls within the scope of our present issue, as these details are of interest rather from a technical than an industrial point of view. The real interest centres around the availability of power and its cost. From the technical side it may be said that the distribution systems for light and power practically all over Canada have now been standardized at 2,200 volts, which pressure is reduced to 550 and 110 respectively for power and light. It appears also to be becoming universal practice to establish three-phase, 60-cycle systems, the chief exception to this being that part of south-western Ontario which is served by the Hydro-Electric Power Commission of Ontario from Niagara Falls at 25 cycles.

The cost of electric energy for both power and lighting shows a gradual but persistent tendency towards lower figures, brought about by marked improvements in design of machinery as well as by improvements in operation and management. The proximity of water powers cannot in every case be taken to indicate the possibility of low rates, as there are many cities and towns in Canada operating under advantageous conditions as to coal, gas and crude oil which give rates comparing favorably with the best hydro-electric plants.

In this connection it might be pointed out that a somewhat erroneous idea has existed as to the percentage cost of the power utilized in general manufacturing. This is much smaller than is usually supposed and, except in rare cases under very inefficient management, does not exceed 10 per cent.

In a general way it may be said without fear of contradiction that at practically every point in Canada, the supply of power, either from water, coal, gas or crude oil, is abundantly ample for any possible contingency of the future.

ORDER OF PUBLICATION

In closing these prefatory observations it may be well to say that these articles will be published alphabetically in the order of the provinces, east to west, given above under the main heading on this page. They will be published in **three parts** in the issues of **May 13, May 20 and May 27.**

It was the intention, in the first place, to tabulate the material presented in the following pages, but the varied character and extent of the information given made such an arrangement impracticable. The articles are presented in concise form consistent with intelligent reading. In many cases it has not been found possible to make use of all the information submitted, but such additional particulars as have been withheld by us are at the disposal of the reader, whom we shall be glad to put in touch with Town and City Clerks, City Engineers and municipal representatives.

Newfoundland

St. John's, Newfoundland

This city has a population of about 34,000. The asessment on rent value in 1912 was $843,139. There are about 33 miles of roadways. The sewerage has a main trunk, with separate and main intercepting systems, the sewage being discharged into the harbor. Sanitary carts collect the garbage, which is dumped. The water supply is drawn from Winsor Lake, four miles away, and conveyed to the city by gravitation.

Nova Scotia

Amherst, N.S.

The town of Amherst was incorporated in 1889. In 1909 the population was 9,130 and to-day it is 11,285. In 1909 the assessment was $3,512,655 and this year it is $4,601,725. The 1914 tax rate is given as probably 22 mills. In 1909 building to the value of $217,000 was carried out in Amherst and the estimate for 1914 is less than half a million dollars. The town has three and one-half miles of bitulithic roadways and contemplates an expenditure of $20,000 on road work during 1914. The sewerage is a combined system, the sewage being discharged into a tidal river. The garbage is collected in cast iron barrels and deposited on a dumping ground near the river. The source of the water supply is the Nappan River and the waterworks comprise a pumping system, storage basin and reservoir. The waterworks extensions contemplated during 1914 will cost $5,000.

Annapolis Royal, N.S.

This centre was incorporated as a town in 1892 and its population at the present time is 1,200. The assessment for 1914 is $321,658 and the tax rate 21.5 mills. There are five miles of earth and gravel roads. There is a sewerage system in a portion of the town, but most of the property is drained off to the river by private sewers and cesspools. A lake, four miles from the town, is the source of water supply.

Canso, N.S.

This town was incorporated fourteen years ago and has a population of 1,630. It possesses fourteen miles of clay and gravel roadways and has no improvements in the way of sewerage or water supply. An electric light plant is being installed at a cost of $15,000.

Digby, N.S.

Digby's population is returned at 1,500 and its assessment at $676,256. Its incorporation as a town took place in 1890. Its tax rate this year is 15 mills. An expenditure of $2,000 is set aside for improvements to its twelve miles of gravelled streets and roads. There is no public sewerage system, private sewers, which drain into the harbor, being in operation. Garbage is collected by carts and deposited in the town dump. The water supply is drawn from the lake and adjacent streams, and conveyed by gravity a distance of three miles to a reservoir near the town.

Dominion, N.S.

This town has a population of 3,000 and was incorporated in 1906. Its assessment for 1914 is $519,000, and its tax rate 25 mills. The town proposes expending $2,000 on improvements to the five miles of streets during the present year. The garbage is collected in carts and dumped. The source of the water supply is Glace Bay, and about $500 has been set aside for waterworks extensions this year.

Halifax, N.S.

The capital city of Nova Scotia was incorporated directly as a city in 1841. In 1909 the population was 44,289 and today it is 55,000. The assessment five years ago was $28,651,050 and the 1914 return is $31,000,000. The tax rate for this year is 20 mills. The building returns for the year 1909 total $538,280, and the estimate for 1914 is in the neighborhood of one million dollars. In 1909 the city engineering expenditure amounted to $313,539 and the estimate for 1914 is $500,000 There are one hundred and one miles of roadways, the types including granite, bitulithic, sheet asphalt, scoria, asphalt macadam, tar macadam, rocmac, porphyry, water-bound macadam and earth. The estimated expenditure for the present year on road work is $75,000. The sewerage is the simple combined system and the method of disposal is by dilution in the harbor. This season an intercepting sewer will be built at a cost of $200,000. Garbage collection is undertaken by the Works Department, teams conveying the refuse to a Stirling incinerator. The water is brought into the city by gravity from the Lakes, there being two systems—high and low service. In the way of waterworks the extensions to be undertaken this season include a distributing reservoir and encircling main estimated to cost $100,000. The electric lighting is operated by private enterprise.

Kentville, N.S.

This town, which was incorporated in 1886, has a population of 2,304. The assessment is rather less than $600,000, there having been no appreciable increase in recent years. The 1914 tax rate is 18.4 mills. The town has thirteen miles of gravel roadways and will expend $5,500 on concrete sidewalks this season. There are three sewerage districts at Kentville—the eastern, the western and the central. The central business district has been laid for seven years and the other districts are to be connected whenever a two-thirds vote of the ratepayers is obtained. The sewage is discharged into the Cornwallis River. The garbage is collected and deposited on a dump. The town's water supply is from Mill Brook, the water flowing from McGill Lake.

Lunenberg, N.S.

The population of this town is 2,700 and the assessment for the present year $1,130,310. There are ten miles of earth roads. A new system of sewerage was constructed in 1913 at a cost of $40,000. The sewage is disposed of in the harbor. The source of the water supply is Canteloupe Lake, the water being pumped to a reservoir of 1,125,000 gals. capacity.

Oxford, N.S.

This is one of the smaller municipalities of Nova Scotia. Its population of 1,200 in 1909 has only been augmented by 92 in the five years to date. The assessment to-day is $275,090 and the tax rate 24 mills. There are six miles of roadways. An expenditure of some $8,000 will be made on local engineering work during 1914.

Pictou, N.S.

Incorporated as a town in 1874, Pictou to-day has a population of 3,300, this being 150 in excess of the population five years ago. The assessment this year is $1,190,020, which is no appreciable increase on that of five years ago. The 1914 tax rate is 25 mills. There are thirty-three miles of roadways, the types being clay and crushed stone, with concrete sidewalks on the main streets. The sum of $4,000 has been set apart for road work this season. There is no proper sewerage system, about two-thirds of the town being sewered privately, the sewers emptying into the waters of Pictou Harbor. The water supply system consists of nine artesian wells, located about half-a-mile from the town limits. The water is pumped into a standpipe, 60 feet by 40 feet, situated on the highest point in the town, and from there is distributed through 12-inch, 8-inch and 6-inch mains. The maximum pressure is 110 pounds and the minimum 45.

Shelburne, N.S.

This town, which received its charter seven years ago, has a population of some 1,500, with an assessment of $371,105. The tax rate this year is 19 mills. There are ten miles of streets and roadways, upon improvements to which an expenditure of $1,000 will be made this year. Nothing in the way of municipal engineering improvements has been carried out, and the only other expenditure this year will be $8,000 on extensions to the electric light system.

Springhill, N.S.

This town was incorporated in the year 1889. It has a population of 6,000—an increase of three hundred during the last five years, in which period the assessment has remained constant at about $800,000. The tax rate for the present year is 25 mills. The road mileage is twenty-four. Only one type of roadway is in use, the material employed being waste from the collieries. The estimated roadway expenditure for 1914 is $3,500. There is no sewerage system excepting street drains. The garbage is collected in carts and deposited on a dump

The water is brought to the town by gravity from a source of supply seven miles distant.

Stellarton, N.S.

This town, which was incorporated in 1889, has a population of about 4,500, an assessment of $1,114,000, and a tax rate of 20 mills. There is no estimate of building work available for the present season, but the engineering department contemplates expending $5,000 on sewerage and waterworks extensions. A like amount will also be expended on road improvements during 1914. There are domestic and also surface drainage systems of sewerage and the sewage is emptied into the river below tide water. The garbage is collected in the usual way and dumped. The water supply is obtained from the river and after filtration is pumped into a reservoir.

Sydney, N.S.

Sydney was incorporated a town in 1886 and as a city in 1904. The population has increased from 15,942 in 1909 to 22,000 in 1914. The total volue of the building work carried out in the former year was rather less than $200,000. The assessment of the city in 1909 was, roughly, $6,000,000, while to-day it is $8,270,400. There are fifty miles of roadways, classified as earth, slag, macadam, and asphalt macadam, with concrete sub-base. The combined system of sewerage in use is gradually being relieved by storm-water sewers. The sewage empties into Sydney Harbor. Within the next few years it is proposed to instal five separate systems of storm-water sewers at an estimated cost of $36,700. The city has no system of garbage collection or disposal. There is a city dump which is controlled by the Board of Health. The source of the water supply is the Sullivan Brook watershed, with an area of 2.3 square miles. The system includes a storage reservoir with a capacity of 200,000,000 Imp. gals. In the field of water-works the extensions planned comprise Middle Lake pumping station and pipe line, estimated to cost $80,000, and 18-inch main for Ward V, estimated to cost $31,000, and smaller main extensions.

Trenton, N.S.

This town was incorporated in 1911, its population at the present time being 2,000. Its assessment this year is $1,125,000 and its tax rate 25 mills. Building work this season will total in value about $65,000. There are five miles of roadways of which there are 2,000 ft. of permanent sidewalks. An expenditure in general improvements will total approximately $18,000, while extensions to the sewerage plant involving an outlay of $18,000 will be carried out this summer. At present the sewage is disposed of in East River. The garbage is collected in carts and dumped outside the town limits. Artesian wells, 300 ft. deep, operated by pumps, supply the water for domestic purposes. A plant is being installed this year at a cost of $50,000.

Truro, N.S.

This town was incorporated in 1875. It has a population of 7,000, an increase of 500 in the last five years. The assessment in 1909 was $2,898,300, as compared with $3,476,200 in 1914. The tax rate this year is 20 mills. The building outlay this season will probably be rather less than $300,000. There are thirty miles of roadways, these being of tarvia macadam, cement and water-bound macadam. The expenditure on roads this season will be $5,000. The sewers are separate system and comprise about 20 miles of mains. The sewage empties into tide-water in the river. Extensions to the sewerage system will be made this season at a cost of $6,000. There is no system of garbage collection and disposal, this being left entirely to the property-owners. The source of the water supply is a brook. A reservoir having a capacity of 30 million gallons is supplemented by a pumping plant at the river. The water works extensions to be carried out this season involve the expenditure of $12,000 and consist largely of replacing the mains with larger pipe.

Westville, N.S.

Westville came into existence as a town in 1894 and has a population of over 4,400 inhabitants. Its assessment is $1,114,000 and its tax rate 18 mills. The building programme this season is estimated to total in value $10,000 and engineering work $7,000. There are twenty-five miles of streets and roadways, classified thus:—stone with field gravel, concrete and ash sidewalks. The sum of $33,600 is the amount set aside for road improvements this year. There is no extensive sewerage system in the town. The water supply is obtained from the Middle River and is pumped into a reservoir after being subjected to filtration.

Prince Edward Island

Charlottetown, P.E.I.

Charlottetown was incorporated as a city in 1855. Its present population of 12,000 represents a decline of 1,000 in half a decade. Its assessment this year is $83,000 and its tax rate 11¼ mills. On street and road improvements an expenditure of $84,000 during 1914 is contemplated. The sewage empties into tidal water. Extensions to the sewerage system are planned and an expenditure of $5,000 will be made in the near future. The garbage is collected by scavengers and dumped. The water supply is obtained from wells and springs, pumped to a reservoir and conveyed to the city by gravity.

Summerside, P.E.I.

This town was incorporated in 1875 and has a population of 3,200—a gain of 400 in five years. In 1913 the assessment was $1,626,940, the gain having been practically negligible in the five-year period. The tax rate for 1914 is 10 mills. The street mileage is about twenty, with fourteen miles of sidewalks. The roadways are earth and macadam, and the sidewalks are of concrete and plank. The sewage is conveyed by two mains to the bay. The water supply is from two artesian wells, 180 feet and 300 feet deep, the water being pumped through the system to a standpipe.

New Brunswick

Campbellton, N.B.

This town was incorporated in 1889. The population has increased from 3,740 to 4,500 during the last five years. Last year's assessment was $36,000 and the tax rate 15 mills. There are seven miles of earth and gravel roadways, and an expenditure of $5,000 on roadways is contemplated this season. The sewerage system is partly combined and partly separate, the sewage being disposed of in tidal water of the Restigouche River. The extensions planned comprise sanitary and storm sewers, with outlet to low water level. The garbage is deposited on a dumping ground outside the town limits. The water supply is brought from lakes by gravity. There are sixty-five fire hydrants and six hundred services. The extensions planned this season include 1,000 feet of cast iron mains and fire hydrants, the whole estimated to cost $2,500.

Chatham, N.B.

The population of this town (5,000), which was incorporated in 1896, has remained practically constant during the last five years. The assessment is placed at less than $50,000 and the tax rate is 25 mills. The street mileage is twenty-nine. There are only 2,600 yards of permanent sidewalks. The sum of $65,000 will be spent on street improvements this season. The sewage is discharged into tidal water.

The water supply is from a brook. The laying of a new conduit at a cost of some $17,000 is contemplated.

Dalhousie, N.B.

This town was incorporated in 1905. Its population is 1,800, its assessment $6,725, and its tax rate 12.7 mills. Water is conveyed by gravity a distance of three miles to a reservoir of 1,500,000 gals. capacity. The system is also equipped with a turbine fire pump operated by electric motor. Provision has been made for an expenditure of $2,000 on the lighting system. The water system was completed in 1909 at a cost of $85,000 and the electric lighting plant in 1913 at an outlay of $30,000.

Edmunston, N.B.

This town was incorporated in 1903. It has a population of 1,850, an assessment of $795,900, and a tax rate of 11 mills. Building work this season is estimated to amount in value to approximately $1,000,000. There are about twelve miles of earth and gravel roads. Improvements in this respect entailing an outlay of $2,000 are contemplated in 1914. The town water is supplied by wells and is pumped to a reservoir about 100 ft. above the highest part of the town.

Fredericton, N.B.

Fredericton, the capital of New Brunswick, was created a city in 1848, has a population of 8,500, an assessment for 1914 of $95,000 and a tax rate of 15 mills. The total value of building done in 1913 was $206,400. The city possesses thirty-two miles of streets and roads, their classification being: Hassam pavement, tar macadam, macadam, clay and gravel. Road improvements involving an outlay of $20,000 will be made this season. The sewage empties into the St. John River. A direct pumping plant conveys the water supply from the St. John River into a basin, after which it passes through filters to a clear water reservoir. It is the intention to extend the system this year at a cost of approximately $10,000.

Moncton, N.B.

The city of Moncton has a population of 15,000 and its assessed value is $7,600,000. It received its town charter in 1875 and became a city eight years later. In 1909 the population was 13,000. Last year the tax rate was 16½ mills. The estimated building expenditure this year is $350,000. There are thirty miles of roads, classified as wood block, macadam and earth, and the expenditure in this department this season will be $50,000. The sewerage, which is the combined system, consists of brick trunk sewers and timber outlets, discharging into a tidal river. The extensions planned consist of 1,000 feet of pipe sewer estimated to cost $1,500. The garbage is collected by teams and burned. The water supply is obtained from two brooks. From storage reservoirs the water is brought by gravity to a pumping station. Waterworks extensions are contemplated at a cost of $8,000.

Newcastle, N.B.

This town was incorporated in 1899 and has a population of 2,500, which has decreased from 3,000 since 1909. The assessment in the latter year was $30,000 and to-day it is $36,000. It is planned to expend $10,000 on road improvements this season. The sewage empties into the river. The water supply is obtained from artesian wells, the water being pumped to a reservoir and distributed by gravity.

Sackville, N.B.

Incorporated a town in 1903, Sackville has a population to-day of about 2,300. Its assessment for 1914 is $1,160,000 and its tax rate 15.2 mills. The streets and roadways are of earth and stone, and concrete sidewalks are at present being laid. The question of constructing permanent streets throughout the town is now under consideration. The sewerage system consists of large wooden mains and vitrified clay pipes, varying in diameter from 14 ins. to 8 ins., the houses generally connecting with a 6-in. pipe. The sewage empties into the river. Frequent extensions to the sewerage system have been carried out and further improvements are contemplated. The source of the water supply is springs, located about three miles from the town. The water is conveyed by gravity.

Shediac, N.B.

This town was incorporated in 1903. Its population of 1,600 in 1909 has advanced to 2,000 to-day. The tax rate for 1914 is 17.5 mills. Five years ago the value of building work carried out was only $5,000. The estimate under that head for the present year is $75,000. The extent of roadways is under four miles. The water supply is drawn from an artesian well. The overflow is taken care of in a reservoir, pumped into an elevated tank and distributed by pressure.

St. Andrews, N.B.

At St. Andrews, which became a town in 1903, the population has increased from 1,000 to 1,200 in the last five years and the assessment in the same period from rather more than $6,000 to $11,000. There are twenty miles of roadways, the classification being given as earth, broken stone and gravel. The sum of $1,500 will be expended on road work this season. The sewage discharges into the harbor. The sewerage system will be enlarged as required, a plan embracing the necessary extensions having been made. The garbage is collected by teams and dumped near the shore. The use of scows in the disposal of the garbage is contemplated in the near future. The water supply is from Chamcook Lake, the water being conveyed through an iron pipe to a reservoir. The town is considering the installation of an electric light system this season.

St. John, N.B.

The city charter of St. John dates back to 1785. The present population is perhaps 45,000, the 1911 census giving it as 42,511. No estimates of expenditure on building and engineering work are obtainable at the time of writing. The city's roadway mileage is 52.3, the various types of construction comprising stone block, wood block, asphalt, tar macadam, broken stone and gravel. The city's sewage is discharged directly into the sea. The garbage is removed at the expense of the property-owners. The water supply is brought into the city by gravitation from lakes. During 1913 about two miles of water mains were renewed at a total cost of $21,862 and 7,000 feet of new pipe was laid at a cost of $20,828. Sewer extensions measured 8,384 feet and the cost was $20,060.

St. Stephen, N.B.

This town was incorporated in 1871 and its population of rather less than 3,000 has remained practically stationary during the last five years. The assessment is $40,000 in round figures and the tax rate for 1914 is 20 mills. There are fifteen miles of roadways, principally macadam, and $5,000 will be expended on road work this season. The sewerage system consists principally of brick mains. The sewage empties into tide water. The water is supplied from a spring three miles distant, it being pumped to a reservoir and distributed by gravity from a 300-ft. head.

Quebec

Beaconsfield, Que.

This town, which was incorporated in 1910, has a population of 1,200 and is assessed at rather more than $1,000,000. The estimate for building and engineering work combined this season is $56,000. There are five and one-half miles of tar macadam and water-bound macadam roads. Extensions to the electric light system are planned at a cost of $20,000.

Chicoutimi, Que.

This town, which was incorporated in 1879, has shown rather rapid development in recent years, the population having increased from 4,000 in 1909 to 6,500 to-day, and the assessment in the same period from $1,300,000 to $2,200,000. It is estimated that building work to the value of more than $1,000,000 and engineering work to the extent of $80,000 will be carried out during 1914. The 1914 tax rate is 12.5 mills. Details of engineering work for the season are as follows:—macadam roads, $30,000; tarvia-filled macadam, $20,000; concrete sidewalks and retaining walls, $20,000, and sewers, $10,000—total $80,000. The present mileage of roadways is fifteen, upon improvements to which an expenditure of $50,000 will be made this season. There is a combined system of sewerage, the method of disposal being by dilution. Extensions to the sewerage system are planned at a cost of $5,000. The garbage is collected in wagons, the method of disposal in use being given as "dilution and fire." The town's water supply is from the Chicoutimi River. At present certain extensions are under way, primarily a 12-inch cast iron pipe being actually under contract for $50,000.

Fraserville, Que.

Fraserville was incorporated a town in 1874 and a city in 1910. Its population has increased from 4,300 in 1909 to 7,000 to-day. The 1914 tax rate is 7.5 mills. The building programme for 1914 is estimated to total in value well over $2,000,000. There are about twelve miles of streets, seven miles of which are gravel and five macadam. About $10,000 will be expended this season on road improvements. There is a complete system of waterworks and sewerage in all sections of the city. The water supply is obtained from the Green River.

Granby, Que.

In 1909 the population of this village was 4,000 and to-day it is 6,000. The tax rate for the year is 15 mills. The roadway mileage is eight, this including four miles of macadam. The sewage is discharged into the Yamaska River. There is no system of garbage collection or disposal. Water is conveyed to the village by gravity under a 300-ft. head from Shefford Mountain. Waterworks extensions in the shape of a 12-in. main estimated to cost $20,000 are contemplated.

Joliette, Que.

Incorporated in 1863, this town has grown in population from 5,793 in 1908 to 7,636 in 1913, the assessment during that period having increased from $1,413,200 to $2,589,220. The tax rate last year was nine mills. The building programme this year is estimated to total in value about $50,000. The roadway mileage is small, but about $15,000 will be expended on bituminous asphalt work this season. The sewage is discharged into the river. The garbage is collected and dumped outside the town. The source of the water supply is L'Assomption River. Reports contemplating the carrying out of considerable extensions to the pumping system have been submitted.

Lennoxville, Que.

In 1909 this village had a population of 1,224, which has now increased to 1,314. The assessment to-day is $453,000, as against rather more than $300,000 five years ago. The tax rate last year was 13½ mills. Building is proceeding on a small scale, the estimates for 1914 being $15,000. There are fifteen miles of earth and gravel roadways, and the 1914 expenditure on road work is estimated at $2,000. The sewage is discharged into the river. Sewerage extensions are planned this season to cost $1,000. There is no municipal garbage system, the refuse being disposed of privately. The water supply is obtained from springs and is also pumped from the river.

Levis, Que.

Incorporated in 1861, this town has a population of 8,000, an increase of 1,000 persons in half a decade. The present assessment, in round figures, is $3,000,000, an increase of nearly three-quarters of a million on the 1909 assessment. The tax rate for 1914 is 7.8 mills. The roadway mileage is twelve, no classification having been furnished. There is a sewerage system in operation. The water supply is from the St. Lawrence River, with steam and electric pumping systems. The electric lighting is owned by the Quebec Railway, Light, Heat & Power Company.

Montreal, Que.

Montreal, the commercial metropolis and national port of Canada, began its real municipal existence in 1833, when the first mayor and council were elected. The population returns for the last half century are illuminating as to the growth of the city. In 1861 the population was 91,000. This had increased to 107,000 by 1871, to 211,000 by 1881, and to 266,000 by 1901. To-day the official figures are, Montreal proper, 568,000, and Greater Montreal, 652,000. The assessed valuation of property in 1909 was $327,000,000 and to-day it is $791,000,000. The building returns for the last five years are as follows: 1909, $7,785,621; 1910, $15,715,859; 1911, $14,759,632; 1912, $19,408,690; 1913, $27,037,097. The 1914 estimated building expenditure for Greater Montreal is $30,000,000. In 1909 municipal engineering work to the value of $1,500,000 was carried out and the 1914 estimate is $7,000,000. Montreal has 480 miles of roadways, the classification being given as asphalt, scoria and granite blocks, 109 miles, and the balance macadam. The estimate for road work this year is $3,800,000. The city's sewers are constructed on the combined system, the main sewers draining mostly into the River St. Lawrence without purification. The sewage discharged into the Back River is purified. Until recently all the sewers were of brick construction, but concrete is now being used for the large sewers. One 8-ft. sewer in Longue Pointe has been constructed of reinforced concrete and brick work. Intermittent filtration is employed, storm overflows discharging directly into the stream. There are two sewage farms, one in Notre Dame de Grace and the other in Upper St. Denis Ward. The Notre Dame de Grace farm, however, is practically useless and the city is building a trunk sewer from Notre Dame de Grace to Cartierville, a distance of five miles. This is being built in three sections, at an approximate cost of $750,000. Montreal's heavy sewerage work has been necessitated by the recent annexation of outlying districts. The extensions planned this season comprise main sewers, with sewage disposal works, the whole estimated to cost $1,500,000. Apart from the waterworks the city does not possess any public utilities, the lighting system, tram cars, power plants, etc., being in private hands. The Contract Record has given so many details about the Montreal waterworks that it is sufficient to say that the source of supply is the St. Lawrence River, at the read of the Lachine Rapids. The water is conveyed to the pumping station through a concrete conduit five miles long. The aqueduct is now being enlarged and a new filtration plant is in course of construction. The city collects the garbage twice a week in carts and has three dumps and one incinerator. The electric light system is owned and operated by the Montreal Light, Heat and Power Company, which has a lighting contract with the city. One of the most important works now being carried out is the construction of an underground conduit system, in which all wires for power, light, etc., will be carried.

Outremont, Que.

Outremont, a suburb of Montreal, was incorporated as a town in 1895 and its population has grown from 2,000 persons in 1909 to 10,000 in 1914. The tax rate for the present year is seven mills. The assessment five years ago was slightly in excess of $3,000,000 and to-day it is over twenty million dollars. The value of the building work carried out in 1909 was $609,000 and the estimated expenditure for the present year is $2,000,000. The expenditure on municipal engineering works for the last four years is as follows: 1910, $139,118; 1911, $491,282; 1912, $348,361; 1913, $245,267. There are 22.4 miles of streets, thirteen of which are macadamized. The town has 23½ miles of 5-ft. and 6-ft. concrete sidewalks. The estimated expenditure on road work for 1914 is $100,000. The combined system of sewerage is in operation, there being 15.6 miles of brick sewers, and 1.1 mile of tile pipe sewers. The sewage is discharged into the sewers of the city of Montreal. The sewerage extensions planned this year are estimated to cost $50,000. The garbage is collected by the municipality, which is contemplating the erection of a small destructor plant. Filtered water from the St. Lawrence River is furnished by the Montreal Water & Power Company. The electric light system will be extended this year at a cost of $75,000.

Pointe Claire, Que.

Incorporated a town in 1911, Pointe Claire has a population of 2,833. Its assessment this year is $1,800,000 and tax rate 7.5 mills. There are six miles of macadam roads. The projected expenditure during 1914 on road improvements will be approximately $90,000, the laying of 4½ miles of roadways being contemplated, but the nature of the surface has not yet been decided on. The system of sewerage is "separate gravity" to central points, where the sewage is pumped into Imhoff sedimentation tanks and treated before discharging into the Lake. The source of the town's water supply is Lake St. Louis, the plant consisting of one 60 h.p. electric turbine pump and one reciprocating steam pump as a reserve duplicate. The normal pressure with standpipe is 60 lbs. and direct from pump 110 lbs. The steel mains vary in diameter from 12-in. to 6-in .

Quebec, Que.

The historic city of Quebec received its charter in 1833. The growth of population in the quinquennial period from 1909 to 1914 has been seven thousand, the figures being 78,000 and 85,000 respectively. The roadway mileage is 80, the types of construction being macadam, asphalt, asphalt block, scoria, brick and granite. This season's road work will consist chiefly of 20,000 yards of bituminous macadam. The sewerage is of the ordinary type and the sewage empties into the St. Charles river. Extensions to the sewerage system are to be made this season, but the details are not settled. Collection and disposal of garbage at Quebec is an open question at present, a new method now being considered by the Health Department. The water supply is from the St. Charles Lake, eight miles from the city. The newly-annexed Belvedere ward has a private aqueduct. Waterworks extensions in Belvedere ward and Limoilou are contemplated. The electric light plant is the property of the Dorchester Electric Company. The installation of another unit of 1,000 h.p. is to be made.

Sherbrooke, Que.

Incorporated a town in 1840 and a city in 1875, Sherbrooke is making constant progress, the population having increased from 15,300 in 1909 to 20,000 in 1914 and the assessment in the same period from $6,300,000 to $9,800,000. The 1914 tax rate is 19½ mills, including schools. Five years ago the building operations carried out during the year (1909) represented an expenditure of rather more than $6,000,000 and municipal engineering work totalled $100,000. The building expenditure for 1913-1914 is estimated at $12,000,000, while engineering work to the value of $200,000 will be carried out. The city has about forty miles of macadam roadways and will spend about $200,000 on road work this year. The sewerage is on the combined system, tile pipe and brick mains being used. The sewage is discharged into the river. The city is now having plans prepared for a new sewerage system, with certain extensions, the whole estimated to cost $200,000. The garbage is collected by the city under the direction of a sanitary officer, the refuse being burned. Water is obtained from the Magog River, at a point four miles up from the centre of the city. The water is pumped by hydraulic power from the source to a reservoir having a capacity of 10,000,000 Imperial gallons. This reservoir is situated 190 feet above the pumps and 320 feet above the lowest part of the city. Extensions to the waterworks are contemplated this season at a cost of $30,000. Extensions to the electric light and gas plants at a cost of $100,000 are under consideration. These will consist of a new concrete dam to be erected at the city's central station to replace the old wooden dam and also the erection of a new gas holder, big enough to store a week's supply of gas. The city has two hydraulic generating plants capable of running separate or parallel, their capacity being 5,500 h.p. There are also two undeveloped water powers, one on the Magog River and the other on the St. Francis River, where 6,000 h.p. could be developed. There are 4,300 electric light and power customers and 700 gas customers. Power is sold at ¾ cents per kw. hour and light at .06 cents per kw. hour, less 10 per cent. discount There is a flat rate for sign and window lighting of $1.50 per 50 watts per annum, and for heating or cooking, .02 cents per kw. hour. Gas is sold at $1.25 per 1,000 cu. ft. net.

St. Hyacinthe, Que.

Incorporated a town in 1850 and a city seven years later, St. Hyacinthe has a population to-day of 11,620. Its assessment is $3,381,875 and its tax rate 7½ mills. The sewage is discharged into the Yamaska River. The streets are of macadam. The source of the water supply is the Yamaska River.

St. Lambert, Que.

St. Lambert was incorporated in 1898. Since then its population has increased from 2,600 to 5,000, its assessment from $1,000,000 to $4,500,000, and its building expenditure from $30,000 to an estimated outlay of $500,000 in the current year. The 1913 tax rate was 8½ mills. The roadway mileage is roughly twenty-seven, the classification being given as: earth roads 22, asphalt 1.43, and macadam 3.82. It is proposed to expend $400,000 during the current year on engineering work. Of this sum $300,000 will be expended on converting the present separate and combined sewage system into a separate system. $150,000 is the estimated cost of sanitary and storm sewers, and $150,000 of a disposal plant on the sedimentation and disinfection plan. It is also intended to expend $100,000 on bitulithic and bituminous macadam pavements and concrete sidewalks. The garbage is collected in open wagons and destroyed by incineration. Water is obtained from the St. Lawrence River and pumped into a water tower by an electrically-driven Worthington turbine, with 540,000 gals. capacity. A set of reserve pumps, driven by steam, have a capacity of 1,050,000 gals. a day, making the total capacity 1,590,000 Imp. gals. The length of the mains is 44,359 feet, the pipes being 4 to 10 in. capacity. It is probable that 17,217 feet of mains and 41 hydrants will be put in this season at a cost of $20,000. Extensions to the electric lighting system are also planned, the cost being $10,000.

Thetford Mines, Que.

Thetford Mines has a population of 7,200, its incorporation as a town having taken place in 1905 and as a city seven years later. Its assessment for 1914 is $2,300,000. The tax rate for 1914 is 7.5 mills. Building this season is expected to be small, only about $3,000 being the estimated value of permits for 1914. On engineering work, however, an outlay of $50,000 is contemplated. There are nine miles of streets, three of which are macadam, the balance being earth. The expenditure under this head during 1914 will be approximately $60,000. The sewage is disposed of in the Thetford River, and a sum of $10,000 will be expended on extensions. There is a gravity system of water supply, derived from springs. The waterworks plant will be extended in the near future at an estimated cost of $10,000.

Valleyfield, Que.

Incorporated in 1875 a town and in 1904 a city, Valleyfield to-day has a population of some 10,000. The streets are macadamized and the sewage of the city is conveyed through vitrified clay pipes and discharged into a tail-race. The source of the city's water supply is the St. Lawrence River.

Verdun, Que.

Incorporated a town in 1907 and a city in 1912, Verdun to-day has a population of 27,000 as compared with 10,000 five years ago. The assessment for 1914 is $350,000, as compared with $100,000 in 1909. In the latter year the building expenditure was rather less than $60,000, while the estimate for 1914 is five and one-half millions. The expenditure on engineering work in 1909 was $200,000 and the estimate for the present season is $500,000. There are twelve miles of macadam roadways in Verdun and the estimated expenditure on road work for 1914 is $100,000. The sewerage is on the combined system, the sewage being discharged into the river after treatment. Extensions to the sewerage system will be made this season at a cost of $75,000. The garbage is collected in carts and deposited on a covered dump. The water supply is from the St. Lawrence River. Extensions to both the waterworks and electric light systems are contemplated. Both systems are municipally owned.

Westmount, Que.

Westmount was incorporated a town in 1895 and received its charter as a city in 1908. The population to-day is 18,500, as compared with 13,000 in 1909, and the assessment is $50,000,000, as compared with $27,000,000. The building expenditure in 1909 was $1,417,600, the estimate for 1914 being $2,000,000. The corresponding figures for municipal engineering work are $178,000 and $131,826. The tax rate for the present year is nine mills. There are twenty-seven miles of roadways, the various types being asphalt, tar macadam, rocmac, bitulithic and macadam. The estimated expenditure on road work this season is over $126,000, which includes the draining and concrete paving of lanes. The sewerage is on the combined system, the sewage being discharged into the sewers of the city of Montreal. The sewerage extensions contemplated this season involve an expenditure of $41,768. The garbage is collected twice a week by horse and motor vehicles, the method of disposal being by means of a Meldrum destructor and a Heenan & Froude destructor, each plant having a capacity of fifty tons The water, which is drawn from the St. Lawrence River and filtered by a rapid mechanical sand plant, is furnished the city by the Montreal Water & Power Company. The electric light system is owned by the municipality, which lights its own streets and also supplies light for domestic purposes. The Montreal Light, Heat and Power Company is a competitor for the domestic supply. It is proposed to carry out an extensive improvement of street lighting at a cost of $250,000, together with the construction of underground conduits. Part of this work, including a portion of the installation of magnetite arc lamps, has already been done.

Ontario (Cities)

Belleville, Ont.

The municipal history of Belleville, Ont., dates back to 1850, when it received its charter as a town. It was incorporated as a city in 1878. Coming down to modern times the growth has been satisfactory in recent years, the population having increased from 9,515 in 1909 to nearly 12,000 to-day, and the assessment in the same period from rather more than four millions to six millions. The value of building work carried out in 1909 was $100,000. The estimated expenditure on building work this season is $400,000 and on engineering work, $63,000. In the way of road work, $45,000 is the estimated expenditure on asphalt concrete pavements to be laid during 1914. The sewage discharges into the Moira River. Considerable extensions to the sewerage system are planned. The garbage is collected in carts and deposited on a dumping ground. Water is obtained from the Bay of Quinte, steam and electric pumps being in operation.

Berlin, Ont.

This town was incorporated in 1854 and received its city charter two years ago. Its population to-day is nearly 19,000, an increase of some 6,000 during the last five years. Last year the assessment was 9½ million dollars, three millions in excess of the figures for 1909. This year's tax rate was 23¾ mills. In 1913 the building work carried out represented an expenditure of $650,000, compared with $350,000 in 1910. The roadway mileage is 29.4, the classification being as follows:—macadam, 24;tarvia, 3, and bitulithic, 2.4. The present season's road work is estimated to cost $100,000. The city has 32 miles of lateral sewers. The trunk sewer built in 1913 consists of 9,500 lineal feet of 48-in. reinforced concrete pipe; 3,300 lineal feet of 30-in. sewer pipe and 5,400 lineal feet of 18-in. sewer pipe. The disposal system consists of three septic tanks, with a capacity of 525,000 gallons, two storage tanks, with a capacity of 450,000 gallons, and sand filtration beds fourteen acres in extent. Extensions to the sewerage system for 1914 comprise new filter beds at a cost of $10,000 and lateral sewers at the same amount. Garbage is collected by contract and dumped on to low ground. The water supply is from artesian wells, the following works having been constructed in 1912 and 1913: concrete water tower, with a capacity of 600,000 gallons, a reservoir, with a capacity of 1,000,000 gallons, and electric pumping equipment. Electric light extensions costing $15,000 are projected.

Brantford, Ont.

The Telephone City, as Brantford has been called, was incorporated as a town in 1847 and received its city charter in 1878. Its population of 20,711 in 1909 has increased to 26,454 in 1914, and the assessment in the same period has grown from 11½ millions to over 20 millions. In 1909 the value of building was $439,335 and the 1914 estimate is $1,100,000, the corresponding figures for municipal engineering work being $242,504 and $275,000. The 1914 tax rate is 22½ mills. The roadway mileage is seventy, classified as follows:—bitulithic, 3; westrumite, 1½; asphaltic concrete, .54; concrete, .20; asphalt block, .05, and macadam and gravel, 64.75. This season the city of Brantford will expend the sum of $60,000 on road work. The sewerage is the separate system, the sewage from the low-lying areas being pumped to main sewer for sanitary sewers. The storm sewers are for storm water only. Both systems discharge into the Grand River. The extensions planned this season comprise street mains for the sanitary sewers at a cost of $50,000 and for the storm sewers at a cost of $20,000. The garbage is collected weekly by the city, which is divided for this purpose into six districts. The garbage is taken from the yards to vacant property owned by the city. The water supply is from the Grand River. The water is filtered by the natural sand process. A direct pressure system is in operation. This season extensions to the waterworks will be made at a cost of $150,000. The electric light system is to be enlarged at a cost of $75,000.

Chatham, Ont.

Chatham came into existence as a county town in 1850, its incorporation as a city dating from 1895. Its population is 13,000 and its assessment last year was $7,264,584, an increase of over $2,000,000 in the last five years. In 1913 its tax rate was 24 mills. The building programme for the present season is estimated to cost $400,000 and the outlay contemplated by the Engineering Department is $50,000. The city possesses eighteen miles of earth roads and fourteen miles of paved streets, the latter being classified as follows: bitulithic, vitrified brick, asphalt block and concrete. An expenditure of $20,000 on road work is contemplated during the present year. A combined system of sanitary and storm sewers is in operation, the method of disposal being dilution in the river. Extensions to the system, involving an outlay of $10,000, are planned. The garbage is collected weekly by wagon and dumped outside the city limits. The source of the water supply is the River Thames, the raw water being pumped into a sedimentation basin with a capacity for a five days' supply. From there it is pumped into mechanical filters through the mains. Extensions to the system have been plannel at an estimated outlay of $5,000. Hydro-electric lighting has been contracted for and it is the intention to remodel the entire lighting system.

Fort William, Ont.

Fort William was incorporated as a town in 1892 and as a city in 1907. Its population has advanced from 18,000 in 1909 to 25,000 to-day. In 1909 the assessment stood at $14,497,240, the amount under this head for the present year being $44,121,979. The estimated tax rate for 1914 is 23 mills. The value of building carried out five years ago totalled $2,970,365, whereas the expenditure in the same connection for the present year is estimated to reach $5,000,000. In 1909 the city expended $465,333 on engineering work, including electric lighting, and the total amount exclusive of the electric lighting improvements estimated for the present year is $1,135,300. There are 128 miles of roadways, 114 of which are graded and the balance distributed amongst asphalt blocks, sheet asphalt, bitulithic, rocmac, macadam and gravel. The expenditure under this head for the present year is $123,900 for paving, $185,800 for road macadam and $145,600 for gravel, a total of $455,300. The sewerage system is the combined type, consisting of tile, 12 in. to 18 in. in diameter, and reinforced concrete sewers, 2 ft. to 7 ft. in diameter. There are 25 outlets, 13 of which discharge untreated into the Beebing River and 12 into the Kaministiquia River. An extension to the system is planned at an estimated cost of $40,000 for 5 ft. diameter reinforced concrete sewers and an equal amount for tile. The garbage is collected by teams and conveyed in gondola cars to a high temperature, 3-cell incinerator. The water supply is drawn from Loch Lomond by gravity, six miles from the city, the system comprising a tunnel, 5 ft. by 4 ft. from the Lake to forebay, and one 24-in. and one 18-in. cast iron main from forebay to reservoir, with two 18-in. mains from reservoir to city. The Kaministiquia and Mission Rivers are crossed by duplicate pipe lines laid under the river beds. Extensions to the distribution mains at a cost of $200,000 are contemplated. The electric lighting system will be extended at an outlay of $75,000 for lines and sub-station.

Guelph, Ont.

The Royal City came into existence as a city in 1879 and its population, which in 1909 stood at 14,060, is now 16,319. Its assessment has increased in the same ratio, it being at present $10,722,533. The tax rate in 1913 was 24 mills. The estimated value of building contemplated this year is $450,000, which compares with an expenditure of $127,625 five years ago. The city has nearly four miles of pavements, consisting of asphalt, macadam, asphalt block and paving brick. Two septic tanks and thirteen filter beds comprise the sewage disposal plant, the effluent being discharged into the river. Teams are employed for the removal of garbage, which is dumped. The water supply is drawn from springs and conveyed by gravity to the city reservoir and thence by steam pump to mains and standpipe. Some $10,000 will be expended on extensions to the electric lighting system. Guelph claims that there is only one other city in the Dominion which supplies power to its citizens at a lower rate, the rate at Guelph being 80c per 1,000 cu. ft. for manufacturing purposes. There are 21 miles of main and 3,000 services. To-day Guelph has eighty manufacturing industries, which have a total capital of $8,500,000. Ten years ago the total capital of the manufacturing concerns was $3,562,641.

Hamilton, Ont.

This city, one of the most important manufacturing centres of Canada, has a population of nearly 101,000. It was incorporated in 1847 when its inhabitants numbered less than 7,000. Its growth has been most marked in recent years, its population having nearly doubled since 1901. Five years ago the population returns were rather less than 67,000. The assessment value to-day is $80,000,000, as compared with $34,000,000 in 1909. The 1914 tax rate is 20 mills. The estimate of building construction this year is $5,000,000. The mileage of permanent roadways is 31, made up as follows: asphalt and wood block, 8.65; brick, .2; wood block, 1.8; asphalt and brick, 4.35; asphalt, 12.3; asphalt macadam, 3.7. About eight miles of pavement, mostly asphalt, will be built this year. The standard pavement for streets having car tracks is with wooden blocks between the rails. The city has two asphalt plants—each of 15,000 yards daily capacity. The paving work is done by day labor. The city's sewage is taken care of by two chemical precipitation plants, the effluent being turned direct into Burlington Bay. One plant, with septic tanks and sprinkler filters, is being remodelled after the Emscher tanks, the effluent to be discharged into the Desjardins canal. The extensions planned involve an expenditure of $250,000. The water supply is from Lake Ontario by direct pumping from the lake to compensating reservoir. There are three intakes into Lake Ontario to the settling basins, from which there are three conduits to pumping station. In the pumping station there are four electrically-driven turbine pumps, each of 7,000,000 gallons capacity every 24 hours, and four pumps driven by steam engines, with a total capacity of 14,000,000 gallons every 24 hours. From the pumping station to the city there are four mains, 18-in., 20-in., 30-in. and 36-in. The high level pumping station, taking water from the city mains, has two electrical pumps, each of one million gallons capacity, pumping to the higher level of the city, which is below the mountain ridge, and two one-million gallon pumps pumping to a tank on the mountain top to supply the residents of that district inside the city limits. The city's garbage is collected by wagons and deposited on city dumps covered with earth to fill low land. In July, 1911, a by-law was passed to raise $505,000 for hydro-electric power and the extensions planned in this department comprise the completion of the work at a cost of $200,000.

Kingston, Ont.

Incorporated as a town in 1838 and as a city eight years later, Kingston has advanced in population during the last five years from 19,000 to over 21,000. Its assessment in 1909 stood at $8,653,625 and is at present $11,949,577. Probably $675,000 will be spent on building this season and about $125,000 on engineering work. The city roadway mileage includes 1.173 miles of asphalt block on 4-in. concrete base and .894 miles of asphaltic macadam on macadam foundation. Seventy-five thousand dollars is the amount set aside for this year's road improvements. A combined system of sewerage is in operation, with outlets into the harbour at different points. Garbage is collected in wagons by contract and dumped beyond the city limits. Lake Ontario is the source of the water supply, the plant consisting of a steam pump of 7,000,000 gals. capacity and a tank holding 628,000 Imperial gallons. The mains are 2-in. to 18-in. in diameter. Extensions to the system involving an expenditure of $30,000 are contemplated. The electric lighting system will be extended by completing the underground conduit system and installing 175 magnetite arcs.

London, Ont.

London was incorporated as a town in 1848 and became a city in 1854. Its population was 49,430 in 1909 and at the present time it is slightly over 55,000. The city's assessment five years ago was $25,664,484, and to-day is, roughly, $33,000,000. Last year the tax rate stood at 24.9 mills. The value of building work carried out in 1909 was $850,134; in 1913 the amount totalled $1,789,920, and the present year's estimate under this head is $2,000,000. In the engineering department rather more than $200,000 was expended five years ago, and the estimate this year amounts to $425,000, made up of the following items:—local improvements, $175,000; construction of part storm sewers, $150,000; sewage disposal and trunk sewer, $75,000; river retaining wall, $25,000. The city's roadways total 136 miles, classified thus:—asphalt, bitulithic, brick, asphalt block, reinforced concrete, macadam and gravel, including 11 miles of permanent pavement. In road construction, extensions contemplated this year amount to $125,000 for the laying of permanent pavements. A combined sewerage system is in operation, this consisting of 14,800 ft. of sewers 24 in. in diameter and larger, 59,200 ft. of less than 24 in. diameter, 9,600 ft. storm sewers of lesser diameter than 24 in., 206,800 ft. of sanitary sewers of lesser diameter than 18 in. and 71,300 ft. of trunk sewers, and three interceptors. The method of disposal consists of sedimentation tanks and bacteria beds, the effluent discharging into the river one mile west of the city. Contemplated extensions to the system include the provision of a disposal site and trunk sewer in the eastern district at an outlay of $75,000. The garbage is collected in wagons and carts, supplied by the city, and disposed of in a 3-cell 50-ton Heenan & Froude incinerator. Surplus steam from the incinerator is utilized in heating a public institution in the vicinity. The source of the water supply is springs and artesian wells. The natural flow water is raised from collecting ponds to the reservoir. The water from the artesian wells is drawn by air lift to a collecting basin and pumped to the mains with turbine pumps. Extensions to the system contemplated involve the laying of new mains at a cost of $73,000. The city will construct a new railway sub-station, line extension, etc., at a cost of $186,000.

Niagara Falls, Ont.

Niagara Falls was incorporated as a town in 1881 and as a city in 1904. Its population, which stood at 8,000 in 1909, is now reaching the 12,000 mark, and its assessment of four and one-half millions five years ago has increased to $8,000,000. In 1913 the tax rate stood at 27.3 mills. The total value of building carried out last year was $500,000. There is a road mileage of forty, composed of brick, westrumite, concrete and macadam. An expenditure on road improvements estimated at $75,000 is contemplated this season. About two-thirds of the total area of the city is drained by brick and tile sewers, with four separate outlets into the Niagara River. Contemplated extensions include two miles of storm water sewers and three miles of main trunk sewers. Garbage is collected in wagons. The source of the water supply is the Niagara River, the waterworks system comprising two direct motor-driven centrifugal pumps of 3,000,000 Imperial gallons daily capacity; 1 triplex double-ended piston pump and one triplex plunger pump of 3,000,000 and 2,500,000 Imperial gallons respectively, driven by hydraulic power.

Ottawa, Ont.

The town of Ottawa was incorporated in 1847 and the city in 1854, three years after which it was proclaimed the capital of the Dominion by Her late Majesty Queen Victoria. In 1867, the year of confederation, the population was 18,700. This increased steadily until in 1909 it was 83,360, while to-day it is 101,000. Five years ago the assessment was $76,000,000, while in 1914 it is over $130,000,000. Last year's tax rate was about 19 mills. The total value of the building work carried out in 1909 was $4,500,000, while the 1914 estimate is $8,000,000, the corresponding figures for municipal engineering work being $400,227 (for 1909) and $800,000 (1914 estimate). The roadway mileage for the city of Ottawa is 154.29, the classification being as follows: asphalt, asphalt and stone block, tar macadam, tar macadam and stone block, stone block, bitulithic, bitulithic and stone block, wood block, tarvia X (modern type), macadam tar painted—a total of thirty-five miles of permanent pavements, the balance being ordinary macadam roads. The 1914 estimated expenditure on road work is $400,000, the greater part of which sum will be spent on asphalt roadways. The City Engineer, Mr. Archibald Currie, has prepared a report upon placing all streets within the city in good shape at a cost of over three million dollars. This report is now in abeyance. The sewerage is the combined system discharging into the Ottawa River. Disposal is by septic tank and dilution. The extensions planned comprise an intercepting sewer at a cost of $100,000. Garbage is collected under contract with the City Cartage Company, of Ottawa, and the city has one refuse destructor of the Heenan-Froude type. The installation of another destructor at the west end of the city is contemplated at a cost of $50,000. The water supply is from the Ottawa River, direct pumping by water and steam power being employed. The capacity is 32,000,000 Imperial gallons a day, with 2,232,000 gals. for the Hintonburg district. There are 160 miles of water mains in the city. The extensions planned comprise a complete new water supply, possibly from the Gatineau Lakes, at an expenditure of eight million dollars, and a distribution system at a cost of approximately one million. The electric light system is to be extended to the Hintonburg and Rideau districts.

Owen Sound, Ont.

The city of Owen Sound, which received its charter as a town as far back as 1857, has a population of nearly 13,000—an increase of some 2,000 during the last five years. The assessment is placed at $6,271,000 and the 1914 tax rate is 28½ mills. There are ninety miles of macadam roads at

Owen Sound, and the expenditure on road work this season is estimated at $10,000. The sewage is conveyed through brick and tile sewers on the semi-separate system and is discharged untreated into the bay. The garbage is collected by carts and dumped on the farm land. The city's water supply is from two gravity systems, the lower from springs and the higher from a spring creek, the maximum pressures being 70 lbs. and 104 lbs. respectively. Slow sand filtration is employed. A reservoir, with a capacity of 5,000,000 Imp. gals., is in use. The electric light system will probably be extended this season by connection with the Hydro-electric development at Eugenia Falls.

Peterborough, Ont.

Incorporated as a town in 1850 Peterborough received its charter as a city in 1905. Its present population of 22,000 represents an advance in the last five years of over 5,000. Its assessment for 1914 is $13,415,464, against $11,192,662 five years ago, and its present tax rate is 25 mills. The estimated value of building work which will be carried out this season is $550,000, and in addition the Engineering Department will be responsible for the expenditure of $250,000. The expenditure in the latter respect in 1909 was $55,000. The city's 55 miles of roadways consist of 2,300 ft. of asphaltic macadam on concrete base, gravel being used over the greater part of the city. The outlay on roadways this season will amount to about $100,000. The separate system of sewerage is installed, storm water being carried to creek and river. The sewage is emptied into the Otonabee River. An improved system is planned, this to consist of a new trunk sewer costing $30,000 and a sewage disposal plant, comprising sedimentation tanks, sprinkling filters and humus tanks, at a cost of $110,000. The garbage is handled by contract and disposed of in a 20-ton Reid incinerator. It is the intention of the city to double the area served during the present year. The water supply is drawn from the Otonabee River, water being pumped directly into the city mains by two single-acting triplex pumps, rated at 2,250,000 gals. a day, one pump of the same type of 3,000,000 gals. capacity and one centrifugal pump of like capacity, all of which are turbine-driven. Some ordinary short main extensions are contemplated for the present year.

Port Arthur, Ont.

Port Arthur was incorporated in 1884 as a town and as a city in 1907. Its population of 11,646 in 1909 and 18,025 in 1913 has grown to approximately 21,000 for the present year. Its assessment has trebled in the last four years, the amount under this read in 1913 being $33,443,960. The estimated value of building this season is $2,600,000, and of engineering work, $1,200,000. The city's roadways total 76.6 miles, classified as follows: paved streets, 4.4; rocmac, 2.5; macadam, 21.8; graded 37.9, the balance of 10 miles being unpaved. An outlay of $200,000 on road improvements is estimated for the present year. A partly combined system of sewerage (mostly separate) is in operation, the sewage emptying into Lake Superior. It is proposed to construct seven miles of trunk sewers, 14.5 miles of intermediate trunk sewers, pumping station and disposal works at a total cost of $2,500,000. The amount set aside for this year's work is $200,000 and for lateral extensions $80,000. The method of garbage collection is by wagons. The provision of a destructor is contemplated. The source of the water supply is Lake Superior, the system in operation being 20-in. intake, 12-in. force main, 10-in., 8-in., 6-in. and 4-in. distributing mains. Contemplated extensions of the system, to cost $550,000, are apportioned between a duplicate 24-in. intake pipe, duplicate 24-in. force mains and duplicate motor-driven pumps. The electric lighting system will be extended by mains and service lines at an outlay of $55,000.

St. Catharines, Ont.

This city has a population of 16,025 and its assessment is $10,874,000. The tax rate for 1913 was 22½ mills. The value of building operations for the year 1914 is estimated at $1,250,000, and the amount to be expended by the Engineering Department will reach $350,000. There are twelve and one-half miles of existing pavements, classified as follows:—bitulithic, 5½; asphalt block, 2½; asphalt, 1½; rocmac, 1½; brick block, 1, and westrumite ½. The contemplated expenditure on pavements this season is $150,000. The city has thirty miles of tile sewers—of various sizes up to 30-in. diameter—in operation, but no disposal works are as yet provided. Extensions to the sewer system for 1914 are estimated to cost $50,000. Stret cleaning and sprinkling are managed by the Works Department, and garbage is collected by contract and disposed of on dumps. A concrete high level bridge on Ontario Street, consisting of thirteen arches of 50 ft. span, will be completed this year at an ultimate cost of $140,000. This is constructed as a local improvement, to open up a sub-division of about 700 lots. The Engineer's report on a second high level bridge across the valley of the old Welland Canal, to connect the heart of the city with the western hill and the G. T. R. station, has been approved. Mr. N. S. Sprague, of Pittsburgh, Pa., has been appointed consulting engineer, and plans and surveys are in progress for the construction of a reinforced concrete viaduct 950 feet long, 80 ft. above water level and provided with a 30-ft. roadway and two 5-ft. sidewalks. The estimated cost of this structure is $175,000, with an additional $60,000 for cost of right-of-way. The bridge is expected to be built in 1915. Among the sewer extensions to be planned this year is a system for the Glen Ridge sub-division of 700 lots, with sewage disposal works and a relief sewer and duplicated outlet for the present main outlet sewer. The city possesses a gravity system of water supply, the source of which is Decew Falls. Extensive additions to the waterworks plant have been decided on at a total expenditure of over $50,000, apportioned as follows:—(1) installation of a sterilization plant at the reservoirs, automatically controlled by a 36-in. Venturi meter, estimated to cost $5,000; (2) the extension of distribution mains on new streets, 4-in. to 12-in., 23,000 ft., at a cost of $32,000; (3) service renewals and improvements on streets to be paved, $4,500; (4) new services estimated to cost $7,000; (5) improvements at reservoirs, $2,500. The city is installing a hydro-electric power and lighting system at a cost of $116,000.

St. Thomas, Ont.

This city, which received its charter in 1881, has increased in population from 10,000 in 1909 to 17,000 to-day, its assessment having grown in this period from rather less than $7,000,000 to nearly $10,000,000. The 1914 tax rate is 22½ mills. The building expenditure this year is estimated at $5,000,000 and the engineering expenditure at $80,000, these figures comparing with an actual outlay of $4,000,000 and $60,000 in 1909. The roadway mileage is 15½, the classification being brick, macadam, westrumite, tarvia, concrete and gravel. The expenditure on road work this season will be $40,000. The method of sewage disposal is by septic tanks. The city obtains its water supply from springs.

Stratford, Ont.

Incorporated in 1858 as a town and in 1885 as a city Stratford has increased in population from 14,500 five years ago to 17,000 to-day when its assessment is $9,900,000. The tax rate is about 25 mills. The building programme for 1914 is estimated at $7,000,000, while an expenditure of $125,000 is contemplated by the Engineering Department. The city has 65 miles of roadways, which are of clay and gravel, macadam, asphalt block, brick, westrumite, taralithic and tarvia, and

$40,000 has been set aside for road improvements this season. There are combined and separate systems of sewerage. The sewage is handled by septic tanks and sprinkling filters. Sedimentation tanks are to be provided at an estimated outlay of $25,000. The garbage is collected by private contract and burned. A systematic city collection and the provision of an incinerator are planned. The River Avon and artesian wells are the source of the water supply, which is distributed through the mains by electrically-driven and steam auxiliary pumps. Mechanical filters are in operation. The extension of the latter are contemplated. An improved system of electric lighting, involving an expenditure of $20,000, is planned.

Toronto, Ont.

Toronto—which, being interpreted, means "A Place of Meeting"—became a town in 1817 and a city in 1834. The population returns are interesting. In 1851 the population was 30,775; in 1856, 45,000; in 1871, 56,000; in 1881, 86,415; in 1891, 144,000; in 1901, 221,583; in 1910, 325,302, and to-day, 445,575. In 1871 the realty value was $22,037,470, a figure which had increased by 1881 to more than $42,000,000. Coming down to more recent times the assessment in 1909 was $227,800,000, while for 1914 it is placed at $516,489,032. The building estimate for 1914 is $27,000,000, while the expenditure in 1909 was rather more than $18,000,000. The outlay upon the various engineering enterprises of the Works Department this season will be nine million dollars, practically treble the amount expended five years ago. The city has 336.47 miles of paved and 185.06 miles of unpaved roads, a total of 521.53. The roadway classification is as follows: cedar block, 4.19 miles; asphalt, 183.80 miles; asphalt block, 6.51 miles; wood on concrete, .77 miles; macadam, 40.31 miles; bitulithic, 42.17 miles; brick, 28.11 miles; gravel, 11.54 miles; concrete, 8.61 miles, and asphaltic concrete, 1.23 miles. The expenditure on road work this season is estimated at nearly four million dollars. The sewerage is the combined system, the mains varying in size from 9 in. to 12 ft. in diameter. Upon the completion of the trunk sewer system all the sewage will be diverted to the sewage disposal works, which consist of sedimentation tanks, pumping and chlorinating plants. The sludge is pumped from the sedimentation tanks into a fenced enclosure in the immediate neighborhood. The effluent, after being chlorinated, passes by gravitation into Lake Ontario. Storm overflow sewers are now under construction at a cost of approximately $1,600,000, these having their outlets at the waterfront. In the way of extensions to the sewerage, a system of sanitary and surface drain sewers have been recommended for the recently annexed districts in the northern section of the city at an estimated cost of five million dollars. The garbage is collected by carts and deposited on dumps. Two temporary incinerators are in course of construction and a combined reduction and incineration plant is recommended at a cost of approximately $720,000. The city derives its water supply from Lake Ontario, the water being brought by gravitation from two intakes and intercepted at the Island, where it is subjected to filtration by the slow sand process. The waterworks extensions comprise the addition of a mechanical filtering plant with a daily capacity of 60,000,000 Imperial gallons, at an estimated cost of one million dollars, together with an 84-in. pipe to tunnel shaft at a cost of $600,000; also extensions to the main pumping station to cost $360,000 and to the high level pumping station at a cost of $250,000, making a total expenditure of $2,210,000. A duplicate waterworks plant at the eastern section of the city is also proposed at a cost of $5,400,000.

Windsor, Ont.

Incorporated as a town in 1854, Windsor received its city charter in 1892. Its growth is emphasized by the fact that its population increased from 12,950 in 1902 to 16,142 in 1909, and to 22,080 in 1913. The population estimated for the present year is upwards of 25,000. The assessment last year was over twenty-one millions, while for 1910 it was rather less than twelve millions. Building progress is indicated by the following returns:—1909, $423,885; 1911, $739,515; 1912, $988,063; 1913, $1,048,975. During the first three months of the present year the building permits totalled nearly a quarter of a million dollars and the estimate for the twelve months is $1,500,000. The total expenditure on street paving and curbs, including renewals, is in the neighborhood of $850,000, the 1913 outlay having been $225,000. The city has about thirty miles of pavements, principally concrete and asphalt block. The estimated expenditure on paving this year is over $250,000. To date about $150,000 has been spent on silex stone walks. The expenditure for walks this year will be about $40,000. The total spent to date on sewers (mainly brick) is approximately $600,000, of which there was an expenditure of $185,000 last year. The estimated expenditure on sewer work during 1914 is upwards of $175,000. The garbage is collected by the city and is at present destroyed in a Walkerville incinerator, which has a capacity of 25 tons in twelve hours. The water system is direct from the River Detroit. Last year extensions thereto comprised a new intake and pumping plant. The 1914 extensions will consist of mains, valves, hydrants and specials at a cost of some $50,000. At present the Hydro-electric Commission are carrying on active work in anticipation of furnishing the city with hydro-electric power about July 1st. The announcement of the location of the United States Steel Corporation's plant at Ojibway is giving the constructional activities of Windsor a decided impetus.

Woodstock, Ont.

Incorporated as a town in 1850 and as a city in 1901, Woodstock has advanced in population from 9,600 five years ago to 10,154 to-day. The city's assessment at the present time is $4,804,920 and its tax rate 22 mills. The building programme this season is estimated to total in value $250,000 and the Engineering Department proposes to expend $11,000 this year—principally on sidewalks, sewers and macadam streets. Of the thirty miles of roads practically all are of macadam construction, half a mile being paved with brick. The sum of $5,000 has been set aside for road improvements during 1914. The sewerage is the combined system, with storm overflow, the method of disposal being septic tanks and filtration. Extensions to the system are projected at an estimated cost of $3,000, divided equally between the construction of a storm sewer and laterals. The city garbage is collected by contract and dumped. The water supply is from springs four miles distant. The pumping system is electrically-driven. Extensions to the electric lighting plant amounting to $10,000 have been planned.

(For Part II—Ontario Towns, Manitoba, etc.—See next issue.)

Sir Thos. Shaughnessy, president of the C. P. R., formally opened the great irrigation dam of the C. P. R. at Bassano, Alta., on April 28. The Bassano dam is said to be the largest in the world, it being longer even than the great Assouan dam.

It is estimated by Mr. Norman L. Harvie, secretary of the railways branch, that 700 miles of railway should be constructed in Alberta this season. It appears that over $11,000,000 is available in Alberta this year for construction of railways guaranteed by the provincial government. The work, which will probably be undertaken this year, includes 75 miles on the Peace River branch, 100 miles on the Edmonton, Dunvegan & B. C. line, 120 miles on the Alberta and Great Waterways road, 100 miles from Oliver to St. Paul de Metes, 175 miles from Calgary to Pincher Creek, C. N. R., together with about 200 miles of steel which should be laid this year on C. N. R. lines already graded in Southern Alberta.

1914 26

The Evolution of Sewage Disposal Methods in Canada

By T. Aird Murray, M. Can Soc. C. E.*

DURING the last six or seven years "sewage disposal" has become an important and much-talked-of problem in Canada, but even at this date, in spite of the advertising which the subject has had from the action of the provincial and other health authorities, very few people appear to have any but a hazy knowledge of what the problem really calls for.

Those who are connected with municipal government are recognizing that a new factor is rapidly developing in civic administration and that the construction of sewers can no longer be accompanied by the simple and economic expedient of discharging the raw sewer contents into the nearest natural drainage location which presents itself. Works of sewage disposal are being demanded by most provincial health authorities before legal sanction can be obtained for raising money by debentures for constructing new sewers, and in many cases communities are being notified that they will be required to install sewage disposal works in connection with several systems of old standing. As a rule the layman has some difficulty in mentally materializing exactly what this demand means, not only with reference to cost and construction, but more particularly as to what one can reasonably be expected to do with sewage in order to produce satisfactory results.

The Meaning of Sewage Disposal

The term "sewage disposal" has come to mean something more than the mere disposing of sewage. It implies that some method of treatment is included by which the disposal of sewage shall not be accompanied by any nuisance either to the community producing the sewage or to any neighbouring community which may be affected by the disposal. In brief, "sewage disposal" implies the construction of certain works calculated to alter the original character of the raw sewage, either by weakening it or changing its chemical character.

Sewage represents practically the water supply of a community after it has been used for cleaning purposes, flushing and carrying away the major portion of human and animal waste products. Sewage, therefore, chiefly consists of water, but the water contains varying amounts of organic matter in the form of suspended solids—solids in solution, and as chemical compounds, mineral matters and also numerous forms of bacteria, many of which are connected with specific diseases capable of transmitting infection. The development of the "water carriage system" by means of underground sewers for the removal of sewage, or "domestic drainage" entailed the concentration of sewage at the lowest topographical elevations, generally represented by a water-course or lake. Thus the custom developed in Canada, as elsewhere, of utilizing water-courses and lakes for the reception and disposal of sewage. The organic contents of sewage commence more or less rapidly to change in character immediately they are mixed with water. By processes known as putrefaction, fermentation and oxidation, the organic matters in sewage are gradually resolved into their elementary mineral constituents. The process of change from organic to inorganic takes place partly in the sewers and more particularly in the water-course or body of water eventually receiving sewage. When the proportion of water to organic matter is below a certain volume, foul odors from liberated gases result from putrefactive processes. Putrefactive processes, however, do not take place where there is a sufficient dilution of water to provide enough dissolved oxygen to oxidize the organic matters.

When dead or effete organic matter is mixed with water, the dissolved oxygen present in the water is gradually absorbed and not until it is absorbed does putrefaction take place. Domestic sewage entering a stream does not poison fish, but the sewage may be of such a volume as compared to the stream that the dissolved oxygen is used up and fish life made impossible. The process of sewage putrefaction taking place in a stream may render that stream as objectionable as an open sewer—foul-smelling, void of fish life, abhorent and dangerous to cattle, and generally providing a nuisance very apparent to the senses. The same apparent nuisance may arise even when sewage is discharged into a large body of water, when the sewage is concentrated in a stagnant dock, bay or portion of the body of water not subject to currents or any cause producing dispersion. It is safe to say that Lake Ontario is capable of oxidising the organic matter of the sewage of many million people, but it is not safe to say that Lake Ontario can be utilized for that purpose, but only probably a very small area of the lake contiguous to the location of the point of sewage discharge. It is apparently very difficult to dispose or mix a volume of sewage with a large volume of water. The author has found areas of sewage-polluted water almost intact with lines of demarcation ten or twelve miles from Toronto Bay. It is more practical, at times, to disperse or mix sewage to the point of desirable dilution in a flowing river than in a lake.

The Esthetic and Sanitary Nuisance

The obvious nuisance due to odors, etc., from putrefactive processes when sewage is mixed with water is not the only or even the most important one. The study by bacteriologists of sewage-polluted waters has proven beyond all doubt that the infective bacteria which accompany sewage will continue in water long after the organic matter has apparently disappeared, and may be present even when the water appears as pure and sparkling as a glass of spring water. It is a demonstrated fact that the organic matter in the Buffalo sewage is mineralized in the passage down the Niagara River to the mouth, but that the water remains infected with colon bacilli.

The question of nuisance is a two-fold one. That which is apparent to the senses may be termed "esthetic" and the other "sanitary," the latter having a direct relation to health and the transmission of disease. It must be apparent that the amount and character of any sewage treatment may be subject to either or both of the above factors of nuisance. In the case of discharging sewage into tidal waters, neither of the above factors may apply. In the case of a small stream receiving sewage the water of which is not afterwards used for domestic purposes, the esthetic nuisance may be the only one requiring attention. On the other hand, with a large river, the proportion of dilution may be sufficient to obviate any esthetic nuisance, but the sanitary nuisance may be of a very grave and important character as in the case of the Niagara, the Ottawa, St. Lawrence, Saskatchewan and other large rivers, which are utilized for domestic water supply.

---

* Of Messrs. Aird Murray and Lowes, consulting municipal engineers, Toronto.

Sewage Disposal With Reference to Canadian Conditions

The amount and even character of sewage treatment is not by any means a fixed factor of general application. There is no one defined complete system of sewage disposal which is the only or the best system capable of general adoption. Sewage treatment cannot be unified in the form of an exact machine, subject to exact cost per capita either for capital or operation charges. A system of a particular character may be efficient under certain conditions meeting certain defined requirements, however, allowing different conditions and requirements, the same system may be either efficient or a wanton waste of money. Local conditions, character of sewage with reference to trade effluents, etc., amount of treatment required, character of stream or body of water receiving the sewage, topography, locality and site for works are all determining factors upon the choice of any particular method and amount of treatment. It is not surprising then to find that the layman is at some trouble in arriving at an understanding as to what sewage disposal really means. The elasticity of method with reference to meeting varying requirements is the reason for this branch of engineering being specialized and confined to the judgment of experts trained particularly in the work. It is difficult to estimate the proportionate value of chemical and engineering knowledge required in order to produce an efficient system of sewage disposal to meet any one set of special requirements. Certain it is, however, that the chemist has done much of late years to explode many unsound theories and put the subject upon a more scientific and certain foundation. The research and experimental work which is being done by many of the health officers and chemists connected with the provincial government of Canada is having its effect already in producing a very advanced and efficient class of work compared with the old, so-called, "septic tank," which up to within a few years ago was considered by engineers and the people generally as the whole thing in sewage disposal.

The Canadian Society of Civil Engineers appointed a committee in 1910 to investigate the question of "sewage disposal" with reference to the pollution of lakes and streams in Canada, and a report was submitted at the Annual Meeting in 1911. The Committee addressed a list of questions to 327 places in all, with the result that the Maritime Provinces, Quebec and Manitoba reported no sewage disposal plants. British Columbia reported one place with septic tank treatment. Ontario reported nine places with septic tank treatment only, four with septic tanks and bacteria beds, one intermittent sand filter, and one with treatment on land. Saskatchewan and Alberta each reported one place with septic tanks and a few places at which modern processes were contemplated at an early date or actually under construction. Since 1910, Alberta, Saskatchewan and Ontario have seen the completion of several up-to-date completed sewage disposal works and several other works are under construction or are proposed at the present time.

It may be taken that public opinion in Canada is in line with reference to the advisability of non-infection of inland waters with sewage bacteria. Several remarkable typhoid epidemics occuring in cities and towns within the last few years have been demonstrated to result directly from the use for domestic purposes of sewage-polluted water. Montreal, Ottawa, Toronto, Fort William and Sarnia have suffered terribly in the past, while the death rate per 100,000 from typhoid throughout the Dominion has been about six times greater than in Great Britain. The use of calcium hypochlorite during the last three or four years in connection with many known polluted water supplies has done a great deal to reduce typhoid. At the same time there appears to be a general feeling of exasperation that the use of chemicals should be necessary in order to provide safe water supplies. That "prevention is better than cure" is a sound axiom and will always be a popular one. Wherever provincial boards of health have taken up the subject of prevention of pollution of water supplies with sewage, their efforts have, generally, been popular with the public. In cases, however, of inter-provincial and international waterways, provincial governments have met with a difficulty in administering laws regulating pollution. For instance, the laws with reference to the restraint of sewage pollution are much more effective in Ontario than in Quebec. Ontario can only administer on one side of the Ottawa River, the other side being controlled by Quebec. In connection with our international boundary waters, towns and cities on the Canadian side hesitate to spend money in sewage treatment works unless there is some guarantee that the towns and cities on the American side follow suit.

Evidence that popular opinion is directed to the above conditions is apparent in the fact that the Parliament at Ottawa are directing their attention to the framing of Dominion legislation calculated to prevent the pollution of interprovincial rivers, while the "International Waterways Committee" have been asked by their respective governments to advise as to what measures should be taken jointly to prevent the pollution of boundary waters. It is understood that a large amount of evidence is being collected which points to the necessity of immediate action, and municipalities may anticipate with certainty that it will shortly become a civic crime to utilize inland waterways, such as streams, rivers and lakes, for the purpose of sewage purification. In the great majority of cases, sewage will have to be treated not only to obviate the esthetic nuisance, but further to eliminate or destroy the sewage bacteria. The statement that cities and towns may filter and chlorinate water supplies will not serve as an answer to the general demand for prevention in the first instance, because it will always be impossible to filter and chlorinate all water supplies taken by individual farmers, used for stock and dairy farming purposes, used by the summer cottages and the lake or river floating population. It is an indisputable assertion that **if the domestic sewage which now discharges by means of underground sewers direct into streams, rivers and lakes without any form of treatment were treated to the extent of the elimination and destruction of the sewage bacteria, at least fifteen hundred lives could be saved annually in Canada from death by**

Sewage Disposal Works, Weston. Ont. Sludge separator tanks and filters covered in.

typhoid alone and this only entails cutting the typhoid death-rate by one-half, yet practically leaving it double that of Great Britain.

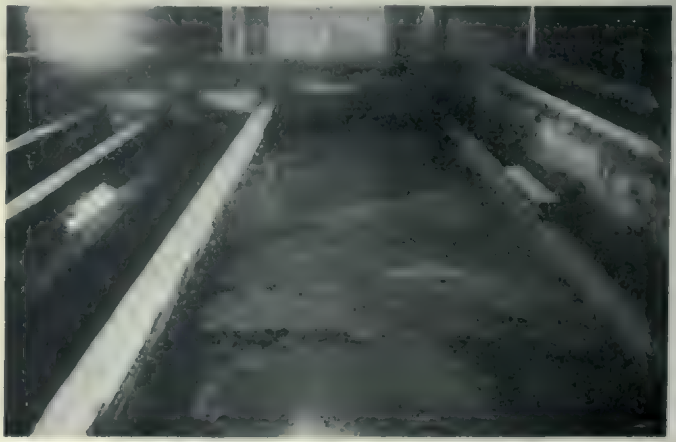
British and Canadian Conditions Compared

The elimination of sewage bacteria or the prevention of the "sanitary nuisance" is of more importance in Canada than in Great Britain, and British methods of "sewage disposal" are only partly applicable to this country. In Great Britain, water supplies are not generally taken from sewage-polluted sources, but from upland surface collecting areas devoid of population. The chief purpose of sewage disposal in Great Britain is to avoid the esthetic nuisance and to preserve fish life. The chief purpose of sewage disposal in Canada is to avoid the sanitary nuisance and to preserve our water supplies as pure as possible from sewage infection. Canada is dependent upon its lakes and rivers to a great extent for water supply. Continued droughts, comparatively speaking low average rain precipitation, hot sunshine in the summer months tending to algae growths in impounded waters, ice covering in winter retaining the gas products of decaying vegetable growth, are all factors which put our water supply conditions on an entirely different footing from those of Great Britain, and in many cases dictate a method of sewage treatment in advance of that generally accepted in Great Britain. For example, the rivers "Don" and "Humber," near Toronto, with their extensive water-sheds would be large rivers in Great Britain, with its generally impervious surface strata and high average rain precipation. These rivers with their large collecting surfaces would form ideal catchment areas for the impounding of water, which under British climatic conditions would vary only slightly in temperature and show decided improvement in the quality of the water the longer it was stored, allowing of sedimentation and exposure to the oxygen of the atmosphere. But practically only during the spring freshets and melting of the snow and ice is there any water to speak of flowing in these rivers. During the summer months they are practically a succession of stagnant pools, the summer rains being absorbed by the friable sandy soil of the uplands and never reaching the river courses. It is for the above and other reasons that Toronto cannot depend upon its water shed to the north for water supply; but must utilize Lake Ontario water, which in turn receives the sewage of its whole population. Toronto is face to face with the problem of destroying the sewage bacteria before the sewage enters the Lake.

Chief Features of Sewage Disposal

Sewage, as has been stated, is water containing organic solids in suspension, organic matter in liquid form either as a solution or chemical compound, and sewage bacteria. There are thus three distinct classes of objectionable ingredients in sewage each of which requires a separate character of treatment, viz., organic solids, organic liquid and bacteria. If the sewage is allowed to enter a lake or a slow running stream, a large proportion of the solids settle by gravity to the bottom, where it gradually rots, a proportion of the solids floating to the surface. The liquid organic

Sludge separator tanks, Weston, Ont. One unit empty.



Sludge separator tanks, Weston, Ont. One unit full.

matter gradually mixes with the water and is oxidized if sufficient dissolved oxygen is present; otherwise it sets up putrefactive conditions. The sewage bacteria gradually die out, but may maintain their vitality for several weeks. Essentially sewage treatment is in line with the first two of the above processes. The solids are separated by gravity and the liquid organic matter is oxidized. The bacteria, however, are not allowed to die at their leisure, but are eliminated by disinfection. The resultant liquid, freed from solids, incapable of further putrefaction and free of sewage bacteria, may then be turned into a stream or lake with impunity. The trouble in the past has been how to efficiently obtain the desired result without nuisance, and without too great a cost commensurate with the results.

The Septic Tank

The old 'septic tank" has suffered more from exaggerated claims which engineers put forward with reference to its supposed capabilities than it should have done if its limitations had been thoroughly understood. A septic tank is nothing more, and can be nothing more, than a tank or receptacle in which the suspended solids in part settle to the base of the tank and in part float upon the surface. The tank in its operation did not oxidize the organic matters in solution, or so change the liquid sewage to an extent to obviate the esthetic nuisance attending its final discharge. The sewage bacteria were not eliminated, and under the most favorable conditions the discharge remained sewage, in most cases providing foul odors which were not even appreciable with the fresh sewage entering the tank.

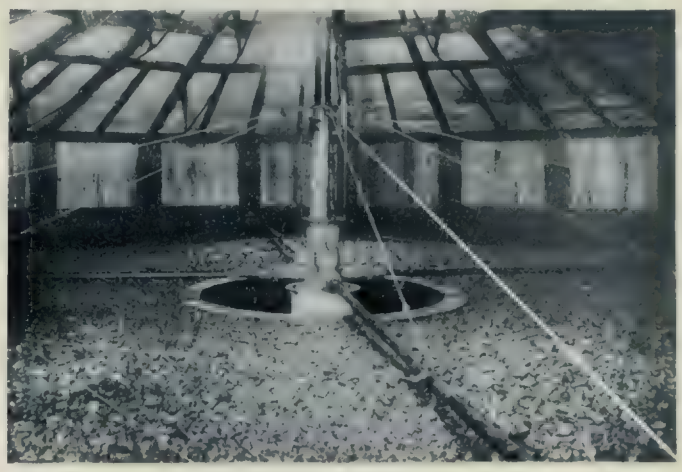
The original claim by the patentees of the septic tank was simply that the organic solids retained by gravity in the tank, if allowed sufficient time, would by a putrefactive process rot to the extent of elimination, and thus the visible matters in sewage could automatically be dealt with. This claim, however, has been only partially met in practice to the extent of about twenty to thirty per cent. elimination of the retained solids. The septic tank has proven itself an inefficient machine for even the purpose for which it was designed. On the other hand, the principle of its action upon solids is the basic principle of the newest type of sewage settling tanks.

Upon the publication of "The Fifth Report of the Royal Commission on Sewage Disposal," in which the limitations of the septic tank were precisely demonstrated, it became apparent that the failure of the tank as a separator of suspended solids lay in the principle of construction, by which the settled solids while undergoing putrefaction were constantly in contact with the fresh flowing sewage, and that if the solids immediately upon settlement could be removed from the settling basin to a separate tank many of the inherent objections to the septic tank could be obviated.

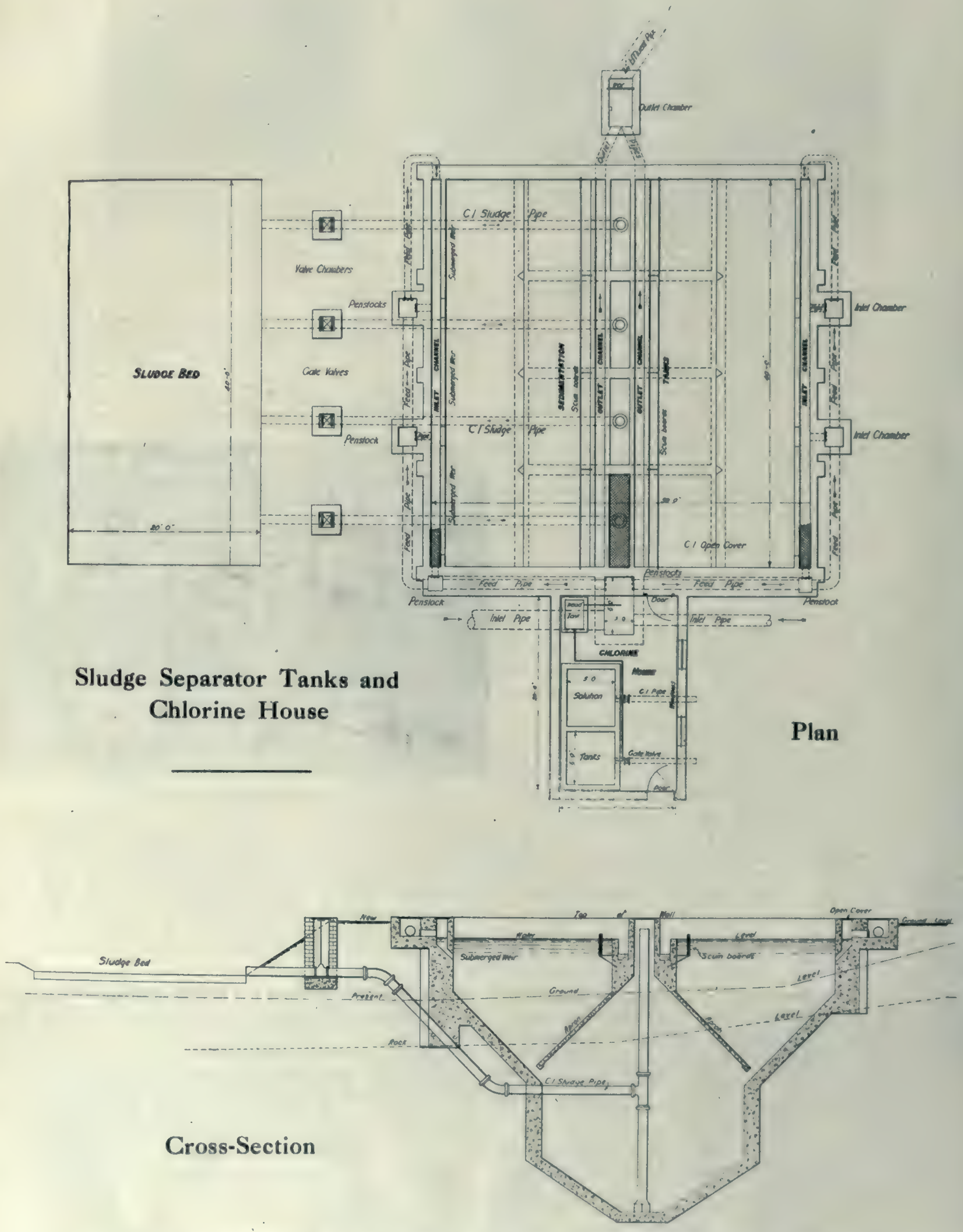
The Modern Sludge Separator Tank

The old septic tank is really the father of the modern "Sludge Separator Tank" or "Two-Storey Tank," as it is sometimes called, the solids of the sewage being retained and allowed to rot by the natural process of putrefaction. Drs. Travis, of England, and Imhoff, of Germany, were among the first to introduce "Sludge Separator Tanks" in Europe, while Rudolph Hering has taken the matter up very strongly in the United States. The first "sludge separator tank" on the two-storey principle installed in Canada was designed by the author in 1910 for the city of Lethbridge, Alta. The principle of the "Sludge Separator Tank" is now generally accepted by engineers and health authorities as an efficient machine for the retention and treatment of the suspended solids in sewage, and although the construction lends itself to variety in design in minor points, the principle of immediate removal of the precipitated solids to a separate chamber and from contact with the continuous flowing fresh sewage is common to all.

One of the illustrations shows a plan and section of an improved "sludge separator tank" of the rectangular type, representing, generally, the design now adopted by the author. The unit consists of duplicate settling basins capable of dealing with the sewage of from three to four thousand population. The sewage is shown to enter first a chlorine treatment chamber from which it is conveyed by feed pipes to an inlet channel baffled by a submerged weir. The weir is carried along the full length of the tank and the flow is directed across the narrow width of the tank to an outlet channel near the centre. The cross section through the tank A to B shows the submerged weir, outlet baffle or scum board, and outlet channel, together with the triangular section used as a settling basin. The velocity of the sewage flow is reduced to almost quiescence in its passage through the settling basin. The settling solids pass through the opening at the base of the settling chamber into the separate sludge storage area, which is common to both settling basins. The sludge storage area is open to the surface for the whole length of the tank to a width of about two feet six inches providing ventilation and control. The cubic area for sludge storage is equal to about four months' collection of solids, this being considered a sufficient length of time to allow of thorough putrefaction. During the process of putrefaction, the gases or products cannot come into contact with the fresh-flowing liquid sewage. The solids are periodically removed from the tank by opening the valve shown and the pressure due to the head of water in the tank above the sludge outlet forces the sludge to drying beds constructed alongside the tank. The resultant sludge from storage basins, constructed as shown, is odorless and when allowed to dry in beds resembles earth humus.


Sprinkling filter, Weston, Ont.

An interesting feature in connection with the tank as illustrated is that the chlorine is applied before the raw sewage enters the settling tanks, and not afterwards, as is generally the custom. It has been dem-

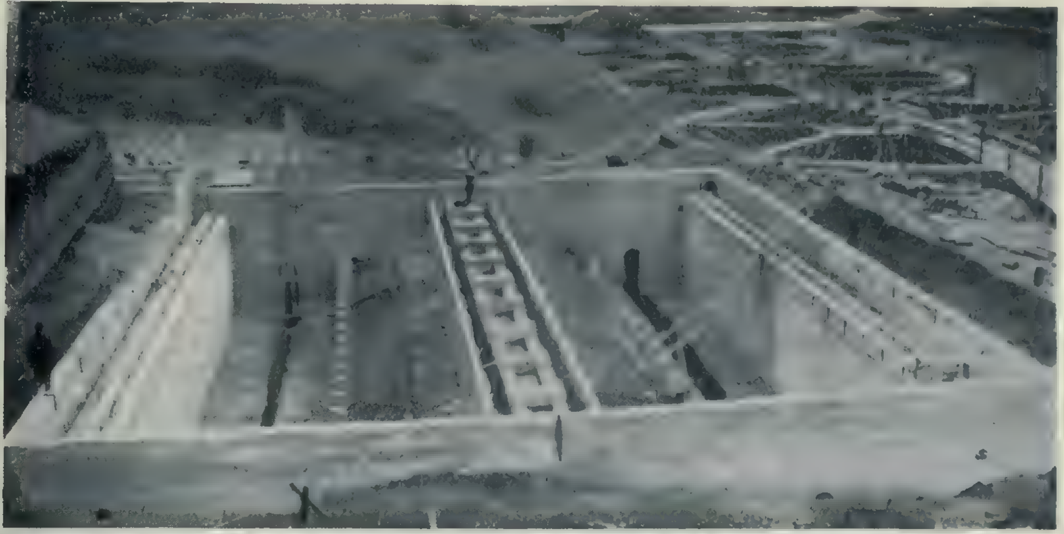


Sludge Separator Tanks and Chlorine House

Plan

Cross-Section

The Evolution of Sewage Disposal Methods in Canada.



Lethbridge Sewage Disposal Works. Sludge separator tanks and filters under construction.

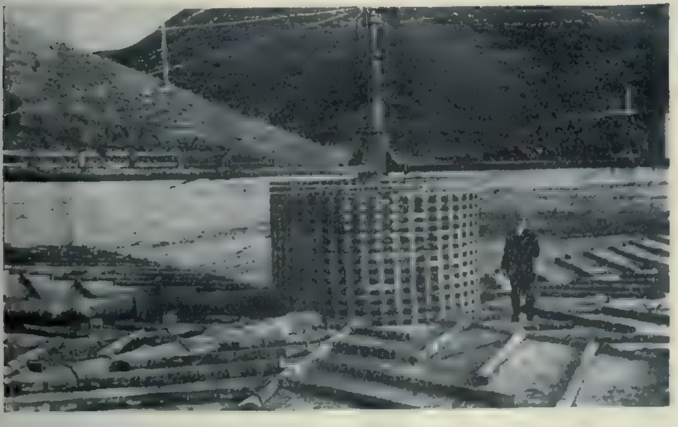
onstrated by the experts employed by the Provincial Board of Health of Ontario at their experimental station that it requires less—or at least no more—chlorine to disinfect the liquid sewage before it enters the tank than after, and that the lime acts as a precipitant upon the solids. The theory appears to be based upon the principle that fresh liquid sewage requires less chlorine than when stale and that the object should be to bring chlorine into contact with the fresh sewage liquid as early as practicable. The solids are, of course, not disinfected and settle with their contained bacteria to the storage basin. In treating water for domestic supply with calcium hypochlorite, it is necessary to settle out the lime before introducing the chlorine, but with sewage both the chlorine and the lime may be added together and so the well-known precipitating value of the lime is utilized in obtaining a greater percentage of settling solids than might otherwise be the case.

Assuming that three parts per million of free chlorine are necessary to disinfect the liquid sewage and the chloride of lime contains 33 per cent. of free chlorine, then it would require 9 lbs. of chloride of lime for every 1,000,000 lbs. of sewage, or 90 lbs. of chloride of lime for every 1,000,000 gallons of sewage. This means that 60 lbs. of lime can be utilized to aid precipitation, which is otherwise a waste product if disinfection is applied as a final treatment.

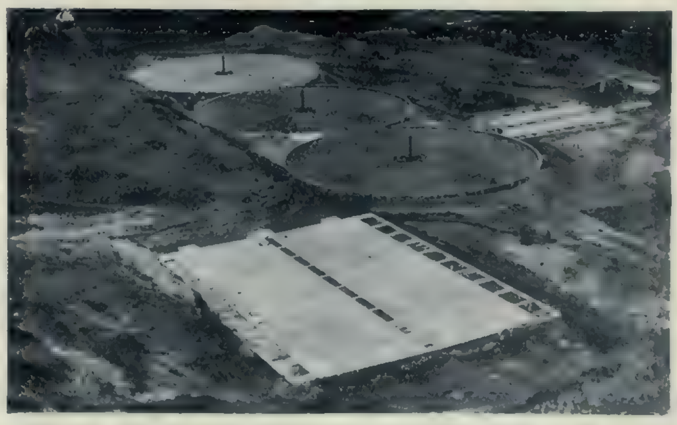
The liquid effluent from these tanks may ordinarily be turned into a stream or body of water, when the dilution is greater than one volume of liquid sewage to thirty of water, without creating any esthetic nuisance. The velocity of flow in a steam, and the efficiency of the method of obtaining dispersion of the liquid sewage in order to obtain the maximum amount or dilution at once, are important factors for consideration. The amount of solids which are settled out average about from 80 to 90 per cent. of the solids which are capable of settling and from 60 to 70 per cent. of the total suspended solids. The effluent continues to contain a proportion of the finer solids, especially those of a specific gravity practically equal to water, which, although not visible in the effluent, will in a small stream form objectionable deposits.

Modern Sprinkling Filters

When it is desired to obtain a liquid effluent which is no longer organic in the sense that it is subject to putrefaction, and which will practically make no demand upon the dissolved oxygen of the water receiving the effluent, the sewage liquid from the tanks may be oxidised by passing it through what are termed "sprinkling filters." There are several installations of



Lethbridge Sewage Disposal Works.
Under-drains and distributor for filter.



Lethbridge Sewage Disposal Works.
Sludge separator tanks and filters complete with humus tank and chlorine house.

these filters both in eastern and western Canada and in spite of the severity of our winters they have proved efficient. The filters are composed of a depth of about six feet of broken stone, slag or other hard material of a rough character averaging in size usually from one to two inch cubes. The rate of filtration at six feet in depth may for ordinary domestic sewage be at about two million gallons of sewage per acre per day, depending, however, upon the organic strength of the sewage as represented by the number of persons connected with the sewers.

The liquid sewage is sprayed over the surface of the filter and percolates slowly to the base, which is very thoroughly drained to the centre. The voids of the filter material are from 50 to 60 per cent. of the cubic area. Not more than 20 per cent. of the voids should at any time be taken up with sewage, the remaining 30 per cent. being taken up with air. The liquid sewage in passing through the filter comes into contact with the oxygen of the air, absorbing it, the character of the organic matter being changed and rendered inoffensive. The fine suspended matter not retained by the settling tank is caught by the surfaces of the filtering material and as it is mineralized it is washed away through the underdrains and generally allowed to settle out by aid of a final settling tank called the "Humus Settling Tank."

Lethbridge Sewage Disposal Works.
Filters operating in winter and giving efficient results.

A Complete System of Sewage Disposal

It will be seen from the above that a complete system of sewage disposal may consist of (a) "Sludge Separator Tanks" removing the bulk of the suspended solids; (b) "Oxidizing Filters" for the treatment of the liquid sewage; (c) "Humus Settling Tanks" for the removal of the finer suspended matters caught by the filters and given off by the underdrains, and (d) Chlorine treatment for the final disinfection of the effluent. There are cases where the requirements may only call for "a," for "a" and "b," or for "a" and "d," and municipalities must rely upon expert advice in this connection. Two complete sewage disposal installations in Canada have lately been the object of several visiting deputations from other municipalities, viz., Weston, near Toronto, and Lethbridge, in Alberta. It is well for those administering civic matters to make themselves acquainted with the practical working parts of an installation before going into the matter. Much is gained by a visit to works where the whole principle can be explained and the results seen and demonstrated. The cost of sewage disposal varies considerably per capita, depending upon the availability of the site, and the amount and character of treatment required. At Weston the plant as constructed will deal with the sewage of 5,000 population at a construction cost of $3.40 per head. At Lethbridge the capacity is for 20,000 population and the cost $3.00 per head. In both cases the system is complete, but pumping is not necessary, and the sites are ideal for the purpose. As a height of from eight to ten feet between the outlet sewer and the effluent discharge is required in order to treat sewage by "a," "b," "c" and "d," as above described, in many cases low lift pumping is a necessity. When "a" and "d" only are required—that is, when the filters can be left out—a height of two feet is ample. The combination of "a" and "d" is, therefore, more applicable to municipalities located with lake frontages.

Sewage disposal will eventually be found not such a costly item as is generally feared, if due consideration be given to actual requirements.

With regard to the question of nuisance from "disposal works," it may be taken and fully demonstrated by modern works at present installed in Canada that there is no odor or nuisance perceptible, and that the fear of nuisance is altogether based upon sentimental notions.

The Meter System as a Preventive of Water Waste

By Herbert J. Bowman, M. Can. Soc. C. E.*

ENGINEERS have long recognized the great difference between the quantity of water required to supply cities and towns in America and that found sufficient in Europe. The truth is that there is an enormous waste of water in this country and it is high time that municipal authorities woke up to the fact. Instead of continually adding to the pumping machinery, what is required is to stop this waste.

The day is coming when every city and town will be required to purify its sewage and not contaminate the streams and lakes, and the first step should be to keep down the quantity of sewage to be treated. This can be done without lessening the amount of water used for flushing the sanitary appliances, or curtailing the legitimate use of water in any way. In the average Canadian city, 50 gallons of water per head of population per day is ample for all purposes if waste is avoided. This is considered a generous supply in Europe and a few places in America have discovered how to manage with this amount. Toronto, Buffalo, Detroit and other cities are daily pumping from 100 to 200 gallons per head. The chief reason for water waste is leaky plumbing fixtures. Of course (in some waterworks systems, much water is wasted by leaky joints in the mains, but where the management is up-to-date this loss of water is being detected and stopped. The great water-waster, after all, is the ball-cock in the closet tank. Although there are often kitchen taps that waste a great deal of water, this waste is easily seen and if the consumer has any conscience at all he will have the trouble attended to.

Now how is this waste to be prevented? In the old country it is done by allowing nothing but the best plumbing fixtures to be used and having frequent house-to-house inspection to see that they are kept in order. Indeed, in some cities the corporation keeps the plumbing fixtures in repair, and all the consumer need do is to telephone to the water-works office and a man is sent to stop the leak. Then in the countries of western Europe there is a better observance of law than we have in the New World, which accounts to a large extent for the ability of their water-works authorities to prevent water waste. In addition to this, labor is cheap in Europe and plumbers' bills are not so high.

---

* Of Messrs. Bowman and Connor, consulting engineers, Toronto and Berlin, Ont.

In America, the best way to prevent water waste is by selling the water, by the gallon, by meter measurement. Many places in the United States and a few in Canada have found this out. Among the latter is the city of Berlin, Ont., where there are 2,917 metered services and only 485 on the flat rate. The latter are limited to small houses having only a kitchen tap. As a result we have a city of 18,500 inhabitants supplied by an average pumping of one million gallons a day. Berlin is noted as an industrial centre and all the factories use city water, there being no other supply. The water pumped on Sunday averages only about 700,000 gallons, so the domestic use is about 40 gallons per head per day and the total consumption of water for domestic and manufacturing purposes runs only a little over 50 gallons per head per day. Having a limited supply of artesian well water Berlin had to make the most of it and for the last twenty-five years we have been using more and more meters until now over 85 per cent. of the services are metered. Ever since the establishment of the sewerage system, over twenty years ago, we have been treating our sewage. At first it was accomplished by broad irrigation on land, but now it is held in septic tanks and then pumped to filter beds. If water waste were not prevented, this could not be done except at a largely increased expense. As it is, Berlin's tax rate is no higher than many other cities that run their raw sewage into the rivers to make trouble for other places below. The municipal authorities do not claim any great credit for treating their sewage in Berlin as there is only a very small creek running through the town. When the broad irrigation beds were overworked some years ago, the farmers along the creek began action for damages, with the result that they collected about $10,000. The corporation then put in the most modern system of sewage disposal appliances.

A typical case of water waste is shown by the following figures taken from the meter register:—

Service No. 2386		Consumer Dr. K——	
March Qtr.	6,250 gals.	at 18c per M.	$1.13
June Qtr.	9,375 gals.	at 18c per M.	1.69
Sept. Qtr.	229,375 gals.	(special rate)	18.16
Dec. Qtr.	8,125 gals.	at 18c per M.	1.47

Here you will notice an enormous amount of water passing through the meter in the September quarter. This was found to have been caused by a defective ballcock in the closet tank. At the ordinary rate for house consumption the bill would have been over $40. This, however, would have made the fine too heavy, so a sliding scale to cover such mishaps has been arranged and the bill paid was $18.16, quite sufficient to make the consumer send for a plumber the next time he sees or hears a leak. However, it is not often that these big bills have to be paid, as the consumers know what the result will be if they are careless. Indeed, the meter system is very popular in Berlin, as the careful consumer with an average-sized house gets off with the minimum water rate of $4.50 a year and has no meter rent to pay.

Another great advantage of the meter system is the equitable water rates that we have. Instead of a flat rate based upon the size of the house, or some other unsatisfactory assumption, the consumer pays exactly for what he gets. To illustrate, the Berlin water rates are given below, the flat rates being given first. All other services are metered.

Kitchen use	$5.00
Stable, one horse	3.00
Each additional horse	1.00
Cows, each	1.00

(Subject to 20 per cent. discount)

Berlin Meter Rates

Up to 1,500 gallons per day, per 1,000 gals.	18c
1,500 to 2,000 gallons per day, per 1,000 gals.	17c
2,000 to 3,000 gallons per day, per 1,000 gals.	13c
3,000 to 4,000 gallons per day, per 1,000 gals.	11c
4,000 to 5,000 gallons per day, per 1,000 gals.	10c
5,000 to 6,000 gallons per day, per 1,000 gals.	9c
6,000 to 8,000 gallons per day, per 1,000 gals.	7½c
8,000 to 10,000 gallons per day, per 1,000 gals.	6½c
Over 10,000 gallons per day, per 1,000 gals.	6c

Recently the Berlin Water Commissioners constructed a new concrete reservoir and concrete water tower and put in new electric pumps. Two turbine pumps were installed, each having a capacity of 800 gallons a minute, one of these being able to pump all the water required. Contrast this with some of the other small cities where they have pumps of a capacity of four and five million gallons a day, necessitated by the waste of water. Water-works officials studying the meter system, will find the Berlin Water-Works superintendent glad to be of any assistance.

A Word About the Annual Number

THE Annual Number of a technical or trade publication must have some particular significance. The day has long since passed when any excuse is accepted for a "special issue." Reading has become specialized; advertising has become specialized. Neither the reader nor the advertiser is easily gulled.

The Annual Number of the Contract Record and Engineering Review has become an established institution. Its appearance coincides with the first real flush of constructional activity. It is designed to show the engineer, the architect, the contractor, the manufacturer, something of the possibilities of the field, something of the development that is taking place, something of the progress that is being made technically. It is not intended to enrich the publisher beyond the bounds of avarice, as the casual observer is only too ready to surmise in glancing over the announcements of more than two hundred progressive advertisers. Its main object is to serve a useful editorial purpose. Upon no other fundamental basis can the standard of a publication like the Contract Record and Engineering Review be maintained and improved. The Annual Number of this journal is for the reader.

While we do not wish to fall under the heinous ban of the commonplace, we cannot refrain from congratulating ourselves upon a policy which has produced the results evidenced in this issue, both from an editorial and an advertising standpoint. That policy has been to attain a higher mark year by year.

The reader will not think that we are unduly elated, we trust. Doubtless he will find many shortcomings in glancing over the pages of this issue, and assuredly we can show him some that he will otherwise overlook. But the results cheer us. The field ahead attracts us. The possibilities of future attainment are alluring. Canada speaks.

Recent Extensions to City of Hamilton Waterworks System

By W. Hollingworth, A.M. Can. Soc. C.E.[*]

OWING to the rapid growth and to the annexation of large areas to the city, it was found necessary in 1912 to increase Hamilton's water supply system so as to provide an adequate supply with constant pressure for a population which at present is 110,000, and also to provide facilities for expansion. The present daily consumption per capita is 100 Imp. gal. In 1913 provision to the extent of $650,000 was made for extensions, which comprise: 48-inch intake pipe in Lake Ontario; 48-inch conduit to pumping station; 36-in., 30-in., 24-in., 20-in. and 18-in. rising mains; electrical pumping station at Beach; electrical pumping station for high level and Mountain pumping system, with rising main and elevated tank for Mountain pumping system.

48-in. header, showing two 30-in. intersecting rising mains with controlling valves.

The city's water supply is taken direct from Lake Ontario. The only opening from Burlington Bay to the lake is at the canal, 3¼ miles distant from the intake pipes, thus obviating any possibility of pollution from the water of the bay. The city may be said to have one of the purest sources of water on the continent, the typhoid death rate for 1913 being only 10 per 100,000 of the population.

Historical Data

The first water works system was constructed in 1857, the source of supply consisting of a settling basin parallel to the lake shore, the water from the lake percolating through the banks and being conducted through a 33-inch wood stave conduit to the pumping station 2,000 ft. distant. The pumping station consisted of two 100 h.p. beam engines, constructed by Mr. John Gartshore of Dundas, Ont., with a combined capacity of 3,300,000 gals. per twenty-four hours. (In 1880 they were enlarged to 5,250,000 gal. capacity) These compound engines, which were the first built in Canada at a cost of practically $96,000, are still retained as an emergency unit. As the consumption of water increased it was found that the percolation of water into the settling basins was insufficient to give the required amount. In 1871 a wood stave intake of 36-in. diameter, was laid through the bank 200 ft. into the lake. In 1876 the settling basins were extended to 2,724 ft. in length by 78 ft. wide and 16 ft. deep, and an additional 36-inch wood stave conduit laid therefrom to the pumping station. In 1886 two additional steam pumping units were installed with a combined capacity of 8,000,000 gallons per twenty-four hours. Again in 1889 the infiltration into the basins together with the short 36-inch intake, was insufficient, on account of low lake level, to give the required quantity of water and a second intake, 850 ft. long of 20-inch cast iron pipe, was laid through the bank into the lake.

In 1910 two electrically-operated turbine pumps were installed with a combined daily capacity of 12,000,000 gallons. The first rising main constructed with the original system was of 18 inches diameter discharging into a reservoir of 11,000,000 gallons capacity, the surface elevation being 187 ft. above Lake Ontario. The 18-inch main was paralleled in 1881 with a 20-inch main, and in 1901 with a 30-inch main. In 1904 a new reservoir was constructed at an elevation of 60 ft. higher than the existing one, of a capacity of 3,000,000 gallons. The old reservoir was then cut off from the system and is now used as a storage reservoir, being held in reserve for emergencies, giving a gravity supply in the event of breakdown at the pumping plant. The head at present pumped against is that of the 3,000,000-gal. reservoir. This is merely a compensating reservoir fluctuating with the city's consumption, and the system may be looked upon as a direct pumping system.

In addition to the main pumping plant there are two re-pumping plants, one for the high level district raising the water to the high level reservoir, sixty feet higher than the compensating reservoir; and the second raising water to the mountain top, 267 ft. higher than the compensating reservoir. Until the time of the waterworks extensions these latter two plants were separate but under the new system these have been combined in one building.

A forty-eight-inch intake pipe was constructed of 7-16-inch steel plate, single rivetted on the circumferential seams and double rivetted on the longitudinal seams, and were shop assembled in 29-foot lengths, then field assembled into lengths approximately 142 ft. long. Rolled steel angles 4-in. x 5-in. x ¾-in. thick, with welded ends, were rivetted to each end. Expansion joints with circular lead gasket in the slip joint were placed at intervals of approximately 600 ft. The total length of the intake pipe is 2,144 ft., and extends from the settling basins directly into the lake, being placed in a dredged channel so that no part of the steel pipe projects above the bottom of the lake. Twenty feet on each side of each joint pile bents are placed to carry the pipe. These pile bents were included in the construction of the work more to keep the pipes at proper grade during laying and bolting than to be of any support after the dredged channel was filled in.

---

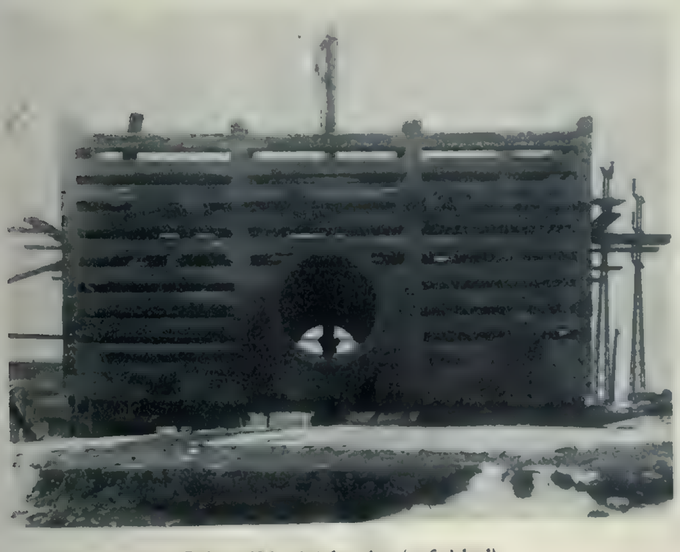
[*] Assistant City Engineer, Hamilton, Ont.

There is practically no scouring action or movement of the sand at this part of the lake.

The pipe is kept below the bottom of the lake for its full distance as the ice in winter occasionally piles up to great heights. The trouble with the original short intake was that the weight of ice would block the crib and pipe. Where the fill on the top of the pipe exceeds 10 ft., concrete in bags is placed around the pipes to prevent deformation, through weight of fill. Joints between flanges are made of corrugated lead and asbestos, similar to that used for steam pipes, with satisfactory results. At the extreme end of the intake in 28 ft. of water an intake crib is placed 24-ft. x 24-ft. x 24-ft. high, built up of long-leaf southern pine, with four corner pockets for stone filling. The screens on the top are constructed of 2-in. x 6-in. white pine laid on edge. This method was adopted to prevent the formation of anchor ice, no iron being exposed on the crib except the heads of bolts.

In constructing this work a sufficient length of channel for one length of pipe only was excavated at one time, piles driven, and pipe bulkheaded and floated near the position in which it was finally to rest. It was then sunk and secured under pipe laying scow, floated over pile bents, dropped and bolted up by divers. Pneumatic tools were used for cutting off piles, drilling for drift bolts and other sub-aqueous work. The plant used comprised a pipe-laying scow with shackles at each end, from which the pipe was suspended (this scow contained a compressor for divers and pneumatic tools), a scow with clam shell for excavating, and an attendant tug. The contractors for this work were the John W. Danforth Company, of Buffalo, New York.

A 48-inch conduit was constructed of concrete pipe reinforced with triangle wire mesh to standard designs of concrete manufacturers. The concrete was mixed in the proportions of 1-2-4, and water-washed gravel and sand used throughout. The pipe is laid approximately 11 ft. below zero lake level and is required to stand internal pressure when working. To obtain a watertight construction and prevent settlement of pipes and breaking of joints after the pipe was laid, the annular space between outside of pipe and side of trench was filled in up to the springing line of pipe with wet concrete which worked well under the pipe. This conduit, the length of which is 1,890 ft., was constructed by the John W. Danforth Company.



Crib to 48-in. intake pipe (unfinished).

Caulking With Pneumatic Tools

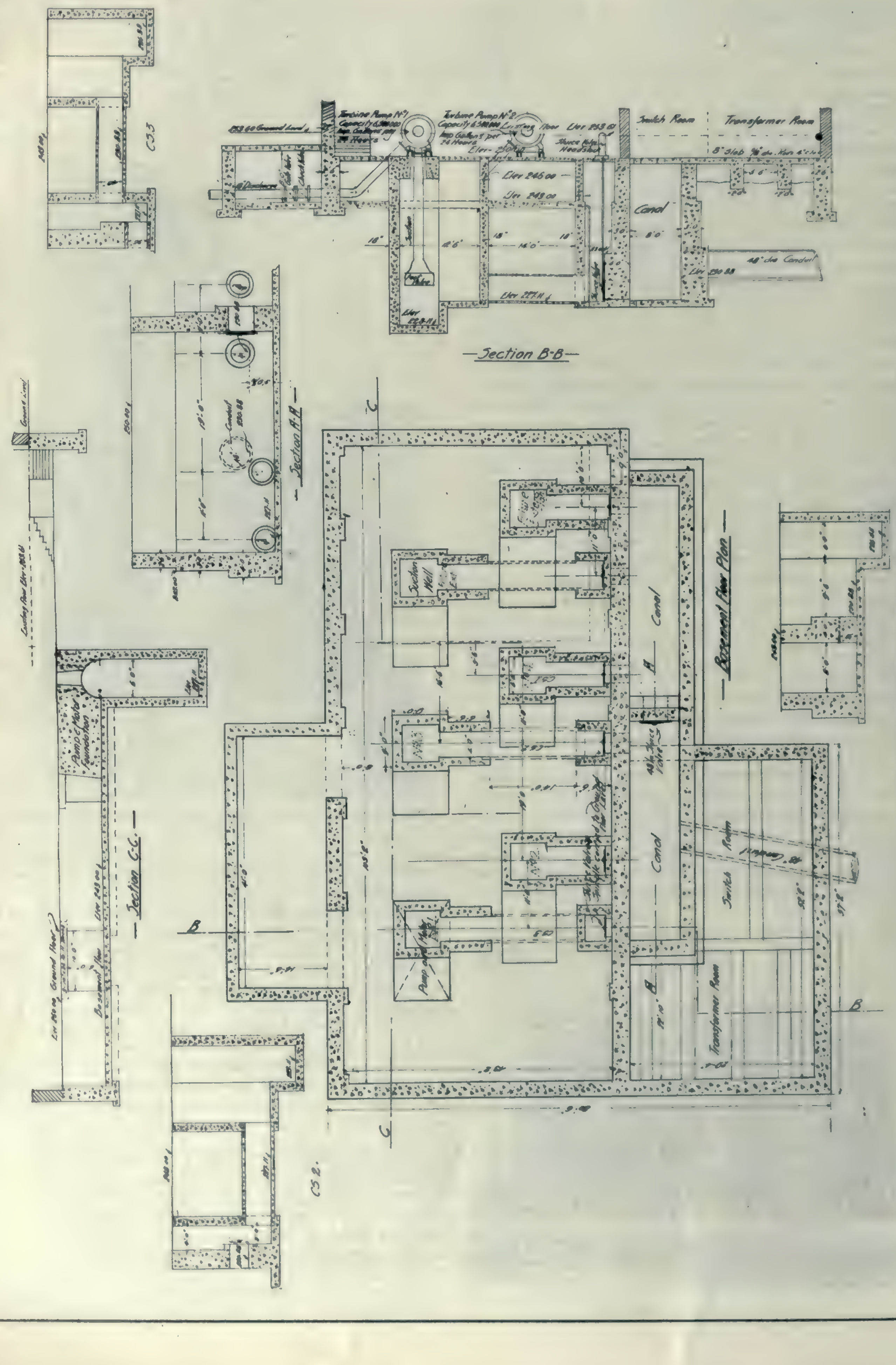
It is not the intention to fully describe the details of the 36-in., 30-in., 24-in. and 18-in. rising mains. Their total length, laid from pumping station to compensating reservoir with sub-mains (given in lineal feet) is:—36-in. diameter, 12,800; 30-in. diameter, 14,796; 24-in. diameter, 5,840; 20-in. diameter, 4,180; 18-in. diameter, 2,653; total 40,178 lineal ft. = 7.61 miles. These mains were laid with a minimum of four feet cover and in some places 14 ft. deep to obviate air pockets. At all high points, double, self-acting, "Klopp" air valves are inserted to allow escape of air during charging of mains and while time mains are under pressure. Connections are made with all intersecting mains over 16-in. in diameter with four-way branches to give generally a better pressure to the existing system.

48-in. header, showing 18-in. and 20-in. intersecting rising mains, Beach Pumping Station, Hamilton, Ont.

The work was carried on by the department on the day labor system and in the case of the 36-in. main, where there were practically no obstructions, a steam shovel was used for excavating and dropping pipes into the ditch. All joints were run hot and caulked with pneumatic tools. In the latter respect it was found that this method of caulking gave a most efficient joint and at a greatly reduced cost over ordinary hand caulking. In the 7.61 miles of pipe laid, on testing and bringing into service, not a single leak was detected attributable to the pipe joints where these had been made with pneumatic tools.

Details of Electrical Pumping Station

The Electrical Pumping Station at the Beach was constructed adjoining the existing station, the intention being to demolish the old and extend the new one over its site. A main feed canal into which the conduits discharge is constructed running the whole length of the building and from which individual feed channels are taken off to each pump suction with controlling valves on each. This will permit of each unit being



General lay-out, Beach Pumping Station, Hamilton, Ont.

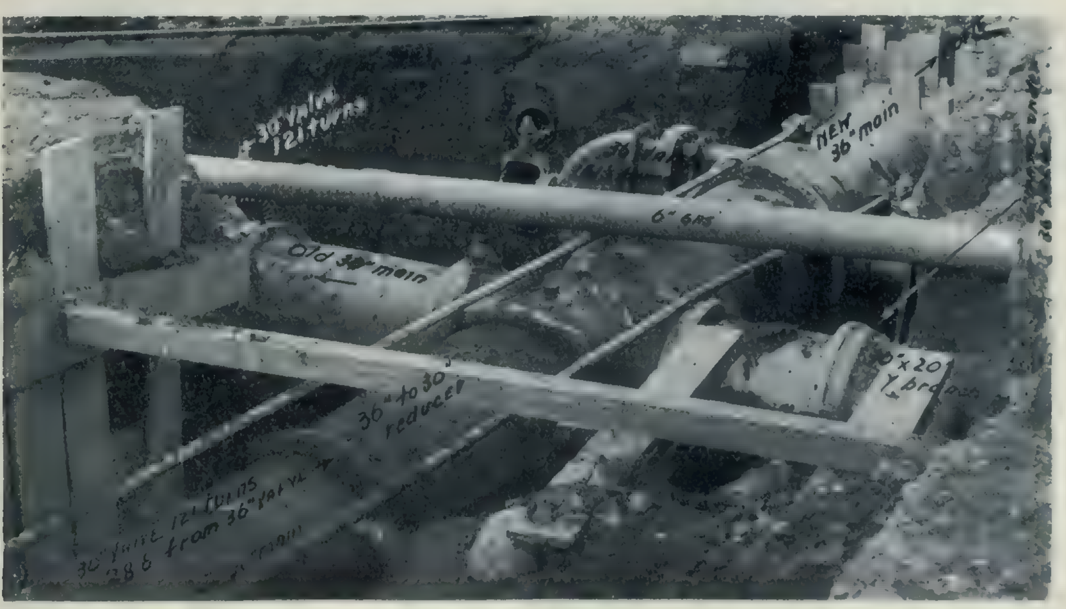
isolated for purposes of repairing foot valves, etc., without interfering with the operation of others. The height of suction lift is kept down in all cases to twelve feet to give greatest efficiency to pumps. The pumping station is equipped with mechanically operated valves on all discharge pipes. The switch room and transformer room adjoining are of fireproof construction. All discharge pipes deliver into a main 48-in. header, with controlling valves on all connections, so that any pump discharge may be directed into any particular rising main in case of repairs to any of the latter. The main header is constructed of 48-in. cast iron flanged pipe and is designed large enough for the extension of an additional 24,000,000 gal. daily capacity.

The pumping station itself will contain at present four electrically-driven units of 6,500,000 Imp. gal. each, with room for extensions on the electrical side to a total capacity of 50,000 Imp. gal. per twenty-four hours. Two of the four 6,500,000-gallon units are 16-in. Worthington two-stage, turbine pumps, direct driven by Canadian Westinghouse synchronous motors. The other two are 16-in. Mather & Platt, special two-stage turbine pumps, direct driven by Canadian Westinghouse Electric synchronous motors. The two first mentioned pumps have been in operation three years and it is the intention to move them into the new pumping station and place them at a lower level to give a suction lift not exceeding twelve feet.

The new electrical pumping station for high level and mountain pumping system now encloses the high level and Mountain pumping systems which up to 1913 had been separate, the latter being a pneumatic lift, direct pressure. This latter was abandoned, however, and the two plants were combined in one building in 1913. The station contains two 7-in. two-stage Mather & Platt turbine pumps, each of a capacity of 1,000,000 Imp. gal. per twenty-four hours for the high level district, and two 10-in. four-stage, Mather & Platt turbine pumps, each of a capacity of 1,000,000 Imp. gal. per twenty-four hours for the Mountain district. The former discharge into the high level reservoir against a head of 131 ft., the latter into the elevated mountain tank against a head of 326 ft. Provision is made for extensions on both systems of an additional 1,000,000 gal. per twenty-four hours for each system. Suction and discharge headers extend under each pump and Venturi meters are placed on each rising main. These act as booster pumps, the water being fed to the pumps at a pressure of approximately forty-five pounds per sq. in. This type of pump gives the advantage of the incoming pressure over the ordinary plunger pump. The rising main from the Mountain pumps to the elevated tank is constructed of high pressure service flanged pipe on concrete pedestals, with concrete thrust blocks to prevent slipping as this is laid at an angle of approximately forty-five degrees from the horizontal.

The whole of this work, with the exception of the completion of the Beach pumping station is now in operation and is giving a reduced friction head at the main pumping station, and a practically unlimited supply of pure water. All designs have been made with the object of giving the highest efficiency in every part of the system, and the existing plants will now be held only as reserve in case of breakdown or repairs to the new plant.

A reservoir with about 120,000 acre-ft. capacity will be built on the Glatzer Niesse, near Ottmachau, Silesia, Germany. It will be the largest reservoir in Germany and its construction is expected to take five years. Of the total capacity, 20,000 acre-ft. will be reserved for flood control; for improving navigation on the river Oder, 70,000 acre-ft. will be provided and it is estimated that in very dry years the river flow can be increased 2,000 sec. ft. The water power can be utilized by fixing the lowest water level in the reservoir. The dam will be about three miles long and it will be the longest in the world. It will consist of an earth embankment with a masonry core. It has been found that one of the strata of the geological formation of the valley is a layer of clay, 25 ft. thick, extending up on both sides of the bluffs, so that the whole reservoir is enveloped by an impervious blanket. The greatest depth of the reservoir will be 40 ft. and its area will be 5,000 acres.



Intersection of 36-in. and 30-in. mains, Barton and Ottawa Streets, Hamilton, Ont. Completed in sixty hours.

Macadam Road Maintenance—with Special Reference to the Use of Oil and Tar

By E. A. James*

WHILE a broken stone road is, under favourable conditions, quite serviceable, it is by no means a permanent pavement and, unless efficiently maintained, will promptly deteriorate.

The agencies tending toward the destruction of roads are so many and so various that it requires constant vigilance to guard against and counteract them. Among those which cannot be prevented the chief are: 1, the grinding and crushing action of wheels; 2, impact of horses' feet, loosening and pulverizing the material of the surface; 3, action of rain water in softening and scouring the surface; 4, action of winds in carrying off loosened material.

Other agencies which with proper care may be prevented are: 1, bringing of mud upon the roadway from the shoulders, causing wagon wheels to pick up the surface; 2, insufficient or poorly maintained drainage; 3, action of frost; 4, the use of narrow tires under heavy loads; 5, tracking of vehicles, i.e., running in the same lines. These last two are the direct cause of a great part of ruts seen on some macadam roads to-day.

Yonge Street, Richmond Hill. Oiled with heavy asphalt oil—two treatments.

The ultimate result of the action of these agencies is a gradual decrease in the thickness of the road surface, and where there is any variation in the hardness of the material, the formation of ruts and depressions. According to present practice the principal idea of maintenance with regard to the surface is to keep it smooth rather than maintain it at its original thickness.

The function of maintenance is therefore to counteract as far as possible the effect of those forces of the former class and to guard against, and where possible prevent entirely, those of the latter.

The first essential to efficient maintenance is of course proper construction. Unless a road is well drained and the material well bound the annual cost of maintenance will be greater than the cost of doing the work right in the first place. Assuming then that the road has been well built, i.e., sub-grade drained and well compacted, surface thoroughly consolidated and bound, with a crown sufficient to shed rain water quickly to the sides, shoulders well formed and side ditches opened with a good grade to carry off all surface water, the purpose of maintenance will be to preserve these conditions. The work will include keeping open the side ditches and all outlets to drains and culverts, keeping mud scraped off the surface, removing weeds from the roadsides and the repairing of all ruts and depressions as soon as they occur. When a depression appears on the surface it becomes a basin to hold water which in turn softens the road and hastens disintegration. Therefore the surface must above all be kept smooth and well crowned.

Since the damage done by frost is always a result of poor drainage it follows that if due regard is paid to drainage at the time of construction and if the efficiency of the drainage facilities be maintained there need be no fear of frost.

The best system of maintenance appears to be the Patrol System. Under this system a man is given a section of road and held responsible for its upkeep. The length of road which one man can properly look after varies with the quality of the material and nature and extent of the traffic. Ordinarily one man can keep from four to six miles in good repair.

The best time for examining the entire length of a section is immediately after a rain. This will show up all ruts and other depressions and also any obstructions or lack of grade in side ditches and culverts.

The best method of filling ruts and low spots in the surface is to pick the stone loose in and for several inches around the depression, add a little fresh stone and grit, wet it, and tamp thoroughly. It may be found that traffic will disarrange the stone somewhat, but if it is gone over a few times at intervals of a day or so it will be found to have set and become an integral part of the road, and, if the work has been carefully done, indistinguishable from the remainder of the road. This work all resolves itself into an attempt to maintain the original contour of the road and to keep the surface drainage perfect.

Another cause of trouble in macadam roads is allowing the earth sides to become cut up and higher than the edge of the stone, thus impounding water that would otherwise run off. These earth shoulders should be kept trimmed below the level of the stone. In this connection an occasional trip over the road with a split-log or plank drag will be found beneficial. By this means the earth shoulders may be kept in such condition that they will often be found preferable for driving in dry weather to the stone section.

The remaining most important part of the maintenance-man's work is the keeping of all ditches, drain and culvert outlets open. This work will be heaviest in the spring and fall, when ditches tend to become clogged with leaves and other debris. During the winter special pains must be taken to keep all these water-courses in first-class working order, bearing in mind that the principal idea in winter is to have a course ready for the water as soon as the snow starts to melt. In this as in other work it is easier and cheaper to anticipate trouble than to remedy it after it occurs.

A discussion of the methods of maintenance naturally includes methods by which wear on road surfaces may be reduced, thus lessening the cost of mainten-

---

*Consulting Engineer, Toronto. Chief Engineer to the Board of Highway Commissioners of York County, Ontario.

Applying "Tarvia A" by auto truck, Eaton Road, York County, Ont.

ance. At the present time the two worst enemies a macadam surface has are the automobile and the narrow tired wagon, the former being particularly detrimental in dry weather and the latter when the surface is wet and inclined to be soft. The narrow tires act as a knife and cut the road. The problem of the automobile is different however. The pneumatic rubber tire has come to stay. The annual increase in the number of automobiles in use during the past few years being sufficient proof of this. The rubber tire of the automobile being absolutely necessary to the comfort of motorists it follows that the road must be made to suit the tire and not the tire regulated to suit the road.

It has been clearly demonstrated that the bond in ordinary macadam roads is insufficient to protect it against the somewhat complex action of the tire of the automobile travelling at high speed. The dust raised by this class of vehicle is blown entirely off the road and a fresh supply raised; this repeated action

Eaton Road, Islington, Ont. About six miles treated with "Tarvia A" in 1913.

resulting in the wearing down of the road surface, in some cases amounting to inches in one season.

The easiest method of preventing wear is by keeping down the dust. This may be accomplished by periodically sprinkling the road, but this method is expensive and unreliable. In hot weather one end of a section will be dry before the sprinkler has reached the other end and the relief will be only partial. Some other means of laying the dust must be adopted. The most satisfactory method is in the use of some of the various road oils.

While oiling a road is not considered a permanent remedy for the disintegration, it serves to keep down the dust, thus preventing successive quantities being raised, and by this means temporarily preserves the road. There are many varieties of oil on the market for this purpose, some of which are little better than water, while others, having a bituminous base, on the evaporation of the volatile constituents, leave a certain amount of bitumen to act as an aid to the binder in the road. This bituminous residue is increased at each successive application which may be made fewer and lighter.

The cost per annum of applying oil at current prices amounts to from eight to fifteen per cent. of the original cost of the road if built by day labor, or from five to ten per cent. if built by contract. This expenditure is justified in the elimination of the dust nuisance and the decreased cost of maintenance as well as in the increased life of the road.

Cost, per application, of oiling one mile of road, of different widths with varying quantities of material.

Oil, 7½ cents per gallon.

Cost of application, $25.00 per mile.

Width of road	Square yards per mile	¼ gallon per square yard	½ gallon per square yard	¾ gallon per square yard	1 gallon per square yard	1¼ gallons per square yard
10	5,867	$135	$245	$355	$465	$ 575
12	7,040	157	289	421	553	685
14	8,213	179	333	487	641	795
16	9,387	201	377	554	729	905
18	10,560	223	421	619	817	1,015
20	11,733	235	465	685	905	1,125

Oil, 8½ cents per gallon.

Cost of application, $25.00 per mile.

Width of road	Square yards per mile	¼ gallon per square yard	½ gallon per square yard	¾ gallon per square yard	1 gallon per square yard	1¼ gallons per square yard
10	5,867	$150	$275	$400	$525	$ 650
12	7,040	175	325	475	625	775
14	8,213	200	375	550	725	900
16	9,387	225	425	625	825	1,025
18	10,560	250	475	700	925	1,150
20	11,733	275	525	775	1,025	1,275

Ordinarily the following applications will suffice:—

First Year—First application, ½ gallon per square yard.
Second application, ¼ gallon per square yd.
Subsequent Years—Two applications, each ¼ gal. per sq. yd.

Brick Pavements—Their Maintenance and Repairs

By F. F. Townsend, C.E.[*]

In travelling over the country inspecting various departments, it is strongly impressed upon one's mind that those in charge of the maintenance and repair of brick streets do not realize their importance or understand the necessary procedure to obtain satisfactory results. It is a well established fact that misuse of pavements does more to ruin them than the traffic ever does, and, as an engineering acquaintance of mine has said, "Brick pavements do not wear out, they are destroyed."

I asked a gentleman of high standing in the brick paving line the following question: "What are the principles of maintenance and repair on a properly constructed brick pavement?" His answer was: "There are none." This was altogether too optimistic for the purposes of this paper, so I found it necessary to drop the word "properly," developing the theory that repairs to brick streets are largely due to mistakes occurring either before construction or during the same, and not to any particular weakness in the materials themselves.

The critical period in the maintenance of the brick pavement is the first two years of its life. There are always a few bricks, even under the best culling, which are left in by oversight. As soon as these bricks commence to shatter or wear unevenly they should be replaced. There are some joints that may not have been properly filled. These should be watched for and refilled if possible. Some cracks may occur, due to frost or uneven settlement, and where these open up sufficiently they should be grouted to protect the edges of the crack. These are the principle items of maintenance on city streets. On country roads a further important item is the cleaning of the ditches. On large amounts of brick country roads around Cleveland, Ohio, and Buffalo, New York, attendance to drainage is practically the only item of maintenance that has been recorded.

Under the item of repairs we will consider all operations which require the removing of sections of pavement, and it will be well to state briefly some of the causes which lead to the necessity for them.

As stated previously, there are some mistakes which occur before construction. These are, generally speaking, mistakes of administrative and legislative officers and can be avoided by the engineer only through advice. I refer to the leaving of underground work upon the street which is handled by city departments or public service corporations until about one week before construction starts. Then the sewer department decides that connections must be made to every lot, likewise the water company has to lower its pipes in order to get below the foundation of the pavement, or the telephone company must get its wires underground. It is a fatal error to leave this work until just before construction, because, as it is generally done in a hurry to get out of the way of the contractors, it has no time to become properly compacted and is very likely to cause settlement and eventually repairs will be necessary.

I was in a city recently where one week after the pavement was grouted the street car company came on and broke holes in the pavement about one foot square at every rail joint, having omitted to bond their rails before construction.

---

[*] Assistant Engineer, Inspection Department, Dunn Wire-Cut-Lug Block Company.

These matters should certainly be governed by ordinances prepared by the city authorities and enforced by them. In many cases the water or sewer connections are left until after construction and we hear everywhere the complaint that no sooner is a pavement laid than we begin to tear it up.

Mistakes in Construction

Then there are mistakes during construction which will make repairs necessary. Some of these are as follows:

(1) Neglect to have the sub-grade properly prepared.

(2) Poor foundation laid upon the above.

(3) Failure to compact properly the sand cushion or have it of uniform depth.

(4) Improper filler or the poor application of the same.

All of these tend to one and the same result—the breaking up of the bond upon the street and the consequent displacement or shattering of the brick themselves.

Poor preparation of the sub-grade and insufficient care in replacing soil over underground work may sometimes be made up for by having an extra good concrete foundation; that is, one which will bridge over the bad places and overcome in this manner the settlement.

If, however, the foundation fails, there is only one way to repair the damage, and the general method will be the same for spots due to poor sub-grade and those due to improper covering of underground work. The bad spot must first be entirely removed down as far as the soft material extends. It is useless to take up the brick and just put in a little sand to bring the spot up to grade, relay the brick and leave it. This method will, in all probability, result in having to do the same thing over the next year and, although in time, after settlement has ceased, we may get a fairly good result, it will be more expensive, and it is better to remove, at once, the cause of the trouble. The next step is to get the cavity thus formed filled with the same material in more compact shape or with some other more suitable material. If the natural sub-soil is sand or gravel, the problem is comparatively easy and in fact it is very uncommon in such soils to have any trouble from this source. If, however, our sub-soil is of loamy nature or of clay, the problem is of a far different nature and must be handled with extreme care. I have known trenches filled with this material, when improperly back-filled, to keep on settling for a year or more after construction. Only last week I was over a pavement upon which the sewer could be traced for nearly the full length of the street. This sewer was constructed two years before the pavement, according to the records of the city engineer's office.

Back Filling Trenches is an Operation of Great Effect Upon the Pavement Laid Over Them

The method most commonly used for back-filling is that known as puddling, consisting of running water into the trench, throwing in the material and allowing it to settle into place. This works very well in many cases, especially where we have deep trench work so that the superimposed material compacts the filling below. This may not, however, be the case in shallow trench work, say from four to five feet. While talking with the repair man of the city of St. Louis recently, he stated it as his belief that the trouble with puddled trenches was due to the top four feet not becoming properly compacted. He stated that trenches four feet deep, put in by puddling, settled about the same amount as trenches sixteen or seventeen feet deep put in by the same method. He prefers gradually to reduce the water up to the four-foot point and tamp the remaining material firmly into place. Every engineer must study the soil with which he has to deal and determine the best methods for his particular locality. In shallow trench work many engineers favor tamping or refilling with gravel and discarding the old material, while in very shallow patch work it is often a good plan to fill the whole space with the foundation course. There are some mechanical tampers now on the market which we believe should give very good results on this class of work. It is needless to say that no back-filling should ever be done with frozen ground, as this will always have large settlement, whatever the material.

The Foundation Course

Poor foundation course is the second trouble mentioned above. It may be caused by leaving the cement out of a batch of concrete or similar mistakes. The affected spot must be removed and put back with care. If it is other material than concrete it must be thoroughly tamped into place, making it even with the remaining base. If concrete is used, the old concrete must be roughened and all loose material and dirt cleaned off so as to get a good bond. It is a good idea to slope the sides of the old concrete base in such a manner as to give the new concrete a bearing on the old, while in some places engineers require reinforcement to be placed in the bottom. After placing this base it must be allowed to set for at least four days before placing the pavement upon it.

A poorly compacted sand cushion or one of excessive depth is the third cause of trouble mentioned above. Upon the properly laid base this should be placed with a uniform depth and thoroughly compacted. It should be so placed that when the brick are laid and tamped they will be even with the old surface. The crowning of patches should never be tolerated. It is simply an admission of the poor quality of the previous work and it never gives satisfactory results. This is especially the case where cement grout filler is used, for the grout will not allow the bricks to settle without breaking the bond and this is the very thing which we desire to correct. If the crowning does not settle there will, of course, be a hump in the pavement, which will be unsightly and an annoyance to traffic.

Filling of Joints

The last item mentioned above, the improper filling of the joints, is one of the most common troubles making repairs necessary. Where sand filler is used, it is an easy matter to re-lay the blocks and sweep in the sand. This is also the case with asphaltic and tar fillers and the advantages of these are that traffic can be immediately permitted. They, however, will require much more repairing, so that the ease in putting them in is counterbalanced by the extra amount. They should never be used to repair grout-filled streets, as they will not harmonize with the rest of the pavement and the blocks put in with them will soon round and become unsightly.

There are two general ways in which grout-filled streets fail. The bond may break up in patches, due to poor spots in the foundation or to now and then a poor batch of grout, or they may fail for entire blocks, due to some fatal error in the method of application. There may be several things the matter with grout, such as poor cement, poor sand or poor mixing, but it is the opinion of the writer that much poor grouting is caused by not regulating properly the amount of water used in each batch. If too little water is used, the grout will not penetrate the joints and we have bridging which will soon break up. This is particularly so where the lugs on the blocks are not properly formed or are too small to give proper spacing. If too much water is used, the grout will be so thin that we will have separation, giving the same result as if it had been unmixed.

The writer was on work last season where there was complete separation, due to excessive water, the sand having settled to the bottom and the cement run away with the excess water. Where either of the above conditions occur generally over the pavement, the whole will break up. Dumping the grout greatly aggravates this trouble, if it is done in large amounts; that is, a grout that if put on with scoops might cause no trouble, when dumped on in large amounts will cause separation or bridging.

Relaying

Where the bond has broken on a pavement there is only one way to correct it; that is to take up the bricks and relay them. Regrouting will do no good, as it will not go in far enough and the bond will soon break up again under traffic. If the pavement is broken up in small patches it is feasible to do this. If, however, the trouble is general, we must ordinarily leave it alone and be satisfied with a filler about as good as sand.

In making a patch the same care must be taken as in the original pavement construction. The brick must be laid smooth and even with the remainder of the pavement, properly tamped in and properly grouted. The traffic must be kept off for a period of from seven to ten days, according to the weather conditions. If these precautions are taken, when finished the patch should look equally well as the other paving. In doing this patching it is the custom in some places to dovetail the work in with the rest of the pavement. In other places they just cut out a square patch and lay the new brick independently of the others. The first method is preferable if it can be done without disturbing the bond on the other pavement, but this is often very hard to do. It is next to impossible unless the blocks used in repairing are of the same size as the original ones. City engineers have at times had trouble in finding blocks to make repairs, it being the custom for different firms to make blocks of different size. When repair time came the company having made the original blocks was out of business and no brick could be found which would fit. There is a commendable tendency at present among manufacturers to standardize sizes so that the different makes will be interchangeable. This is evidenced by the fact that the sixteen firms which make the Dunn wire-cut-lug block have agreed to make a size which will lay just forty to the square yard and be interchangeable. This we believe will overcome the former difficulty.

Uniform joints of proper width are also very desirable on paving blocks, and this is attained in a high degree on the wire-cut-lug blocks. The lugs being cut on cannot be malformed.

In regard to the cost of maintenance and repair, little can be said, because records are very scarce. The Bureau of Municipal Research, of Cincinnati, Ohio, found the cost of maintenance and repair to be 1.2 cents per square yard per year. The city of Baltimore found the cost to be ½ cent per square yard The representatives of both cities stated that the figure was hardly fair, as it took in some very poorly constructed streets. Some of the streets properly put in had shown no maintenance and repair charge for a long term of years.

Low Level Bridges at Edmonton, Alta.

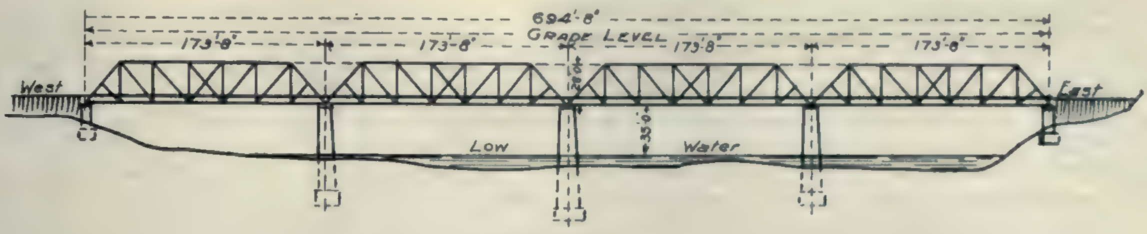
By H. F. Christie, Assistant City Engineer, Edmonton.

OWING to its rapid growth and consequent increase in traffic across the river the city of Edmonton, situated on the north branch of the Saskatchewan River which separates the northern and southern portions of the city, required additional accommodation for the trans-river traffic which was carried solely by the McDougall bridge, erected in 1900 by the Dominion Government. At present there are three low level bridges within the city, viz., McDougall, east end, completed in 1912, and Fifth Street, completed in 1914.

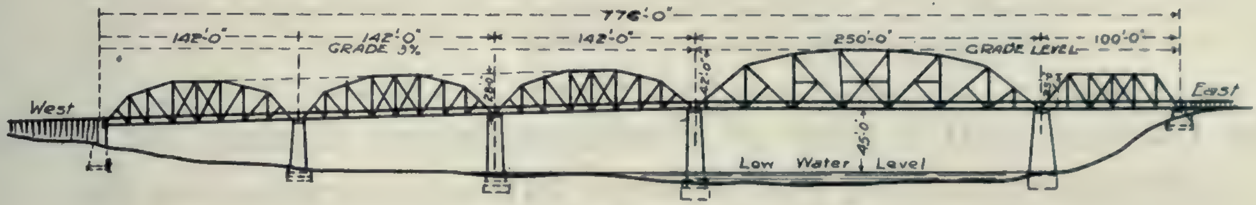
McDougall bridge accommodates steam, street railway, vehicular and pedestrian traffic, on a roadway of seventeen feet and two outside sidewalks 4 ft. 4 in. wide. When steam traffic occupies the bridge all other traffic is suspended. The structure is composed of four equal spans of 173 ft. 8 in., making a total length of 694 ft. 8 in. The trusses are the rivet connected Pratt type, 170 ft. 11 in. centres of bearing pins and 28-feet-deep centres of chords. The substructure consists of concrete piers with foundation on hard shale and abutments on timber pile foundation. The clearance height from low water level to superstructure is thirty-five feet.

As to the location of the east end bridge three sites were proposed and investigated. The first suggested was at River Street, but this was considered too near the existing bridge and was therefore rejected. The second site was at the bend of the river in line with the Clover Bar Road. This also was rejected on account of the unstable bank on the east side of the river. The third proposed, and present site, was decided upon as the most desirable location, especially having regard to the district served and the grade of the roadways approaching the bridge. The roadway on the east side of the valley has a maximum grade of eight per cent., that on the west side having a maximum grade of six per cent.

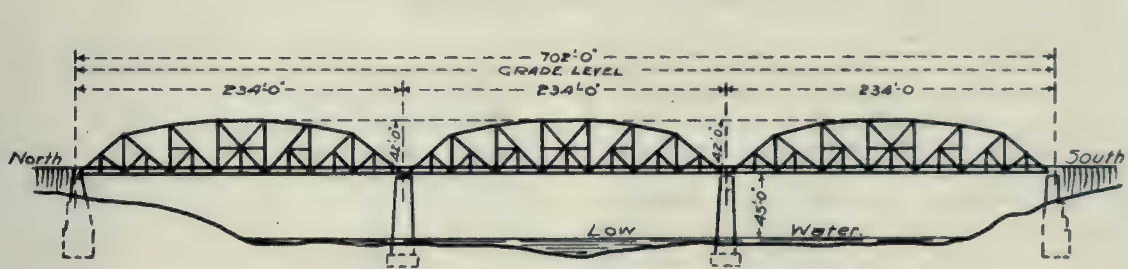
The Dominion Government regulations demand a clearance over the channel of forty-five feet from low water level. Owing to the difference in the level of the channel span and the roadway at the west end of the bridge, it was necessary to place the three approach spans on a grade of three per cent. This bridge accommodates street railway, vehicular and pedestrian traffic on a roadway twenty-four feet wide and two outside sidewalks six feet wide. The three grade approach spans are each 142 feet long, channel span 250 feet, and west approach span 100 feet, making for the structure a total length of 776 feet. There are three types of trusses, all rivet connected, in the bridge. The grade approach spans are Pratt trusses with curved top chord, the channel span Petit truss, and the west approach span Pratt truss. It may be claimed in regard to the last mentioned truss that for appearance it should have a curved top chord, but from an engineering point of view, having regard to the channel



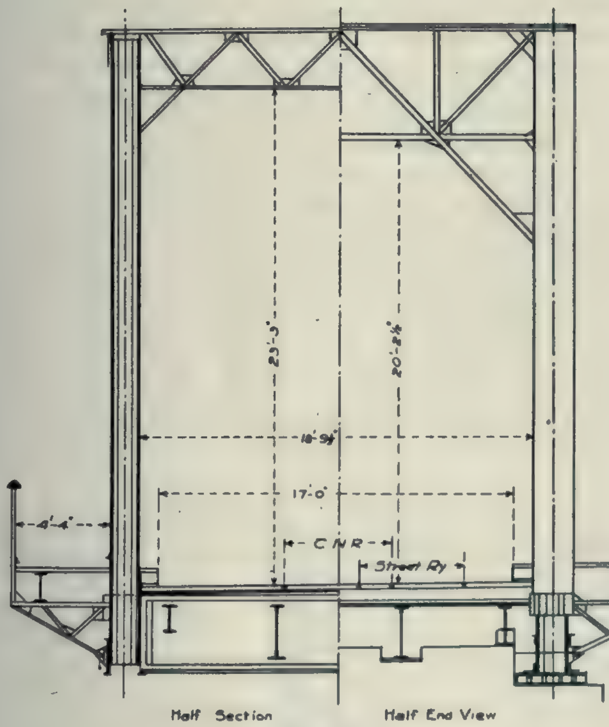
MacDougall Bridge.



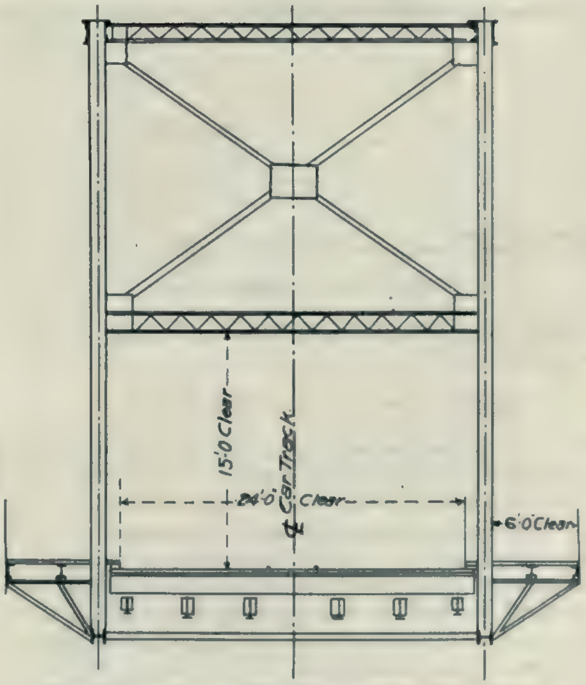
East End Bridge.



Fifth Street Bridge.



MacDougall Bridge.



Typical Cross-Section—Fifth Street and East End Bridges.

Low Level Bridges at Edmonton

of the river, length of span and loading, it would be incorrect to curve the top chord.

The substructure consists of concrete piers and abutments with foundation on hard shale except the east abutment which rests on hard clay. When the cities of Edmonton and Strathcona amalgamated, it was agreed that a bridge should be constructed across the river, in the vicinity of Fourth Street, Edmonton, thus deciding the location of Fifth Street bridge. This structure is similar, in respect to traffic accommodation, to the east end bridge, the cross sections of the two bridges being practically alike. The roadway approaching the bridge on the south side of the valley has a maximum grade of five per cent., and on the north side a maximum grade of twelve per cent. The trusses are rivet connected Petit type, each 230 ft. 5 in. centres of bearing pins, and have a maximum depth of 42-feet centres of chords. The total length of the structure is 702 feet.

The foundations of the concrete substructure is hard shale. The foundations for the abutments having been carried down on account of layers of soapstone, the presence of which was disclosed by the test borings.

The floors of both the east end and Fifth Street bridges are similar. Timber ties of 10 x 10 in. fir, about 2 ft. 6 in. centres, are laid transversely on the steel stringers, then 4-in. longitudinal planking is laid on top of the ties, and the wearing surface of 2 in. x 4 in. tamarac, laid on edge at an angle of forty-five degrees to the centre line of the bridge, rests on the planking.

The Design and Value of Sedimentation Basins for Water Purification and Softening Plants Operated on the Continuous Principle

By Alexander Potter, C.E., Consulting Engineer, New York City.

SEDIMENTATION, either alone or in conjunction with other processes, is used in nearly all water purification plants. Irrespective of whether the settling process is carried on with or without the aid of chemical precipitants and coagulants, sedimentation basins can be operated either by the fill-and-draw method, a strictly intermittent process, or more or less continuously. The fill-and-draw method of operating such basins is not now generally used, as the continuous process gives quite as good results as the intermittent one and possesses an economic advantage of delivering the settled water at practically the level at which the raw water is admitted to the basin.

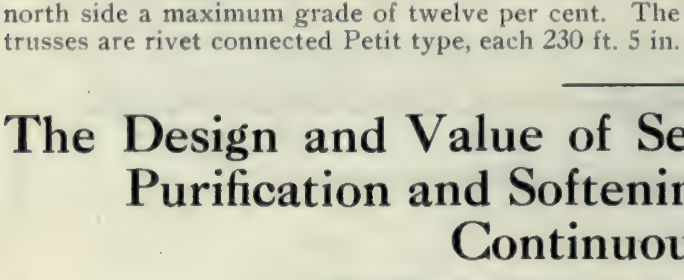


Fig. 1—Settling basin operated continuously.

QUIESCENCE IS ESSENTIAL

In a sedimentation basin operated more or less continuously the unsettled liquid enters the basin at one end and the settled water is drawn off at practically the same rate at the opposite end of the basin. When there are a number of such basins they can be operated either in parallel or in series, depending upon local conditions and the character of the water. Better results are obtained by basins operated in series than those operated in parallel.

Disturbances created in settling basins tending to lower the settling efficiency are due to several causes, namely: vortex motion, set up by the kinetic energy of the inflowing liquid, disturbances which are apt to continue for a long time when once set up; and the currents set up by the action of the wind, or by the temperature changes which take place in the liquid in the settling basin.

There is no reason why when a settling basin is operated continuously, the process should be materially interfered with by vortex action caused by the inflowing liquid, as long as the currents and eddies due to the inflowing water are prevented from reaching the main body of the settling chamber proper. Just as good results can be obtained in a basin operated continuously as in one operated on the fill-and-draw method and at much less cost. The method, illustrated in Fig. 1, of having the liquid enter the basin in a direction opposite to that it must take in traversing the basin, appears to be a very simple and effective way of arresting vortex motion by impinging the current against the wall of the basin.

Other methods have been used more or less successfully. One is to introduce the raw water at one end of the basin in a downward direction through one or several inlets. Such inlets are known as downtakes and should, to be effective, be carried down about two-thirds of the depth of the basin. When the water is introduced into the basin in the same direction that it must take in passing through it, vertical baffles placed a short distance in front of such inlets can be used to arrest the currents and eddies caused by the inflowing liquid and prevent them from disturbing the quiescence of the settling compartment.

SLUDGE PROBLEM

The organic and inorganic matter removed from the water by sedimentation collects in the bottom of the basin in the form of a semi-liquid sludge. This sludge on standing gradually compacts, the consistency attained depending upon its composition. Frequently it is such that the sludge stands at a very steep slope for a considerable time. This deposited sludge often reaches, in a very short time when turbid waters are treated, such volume that unless frequently removed the space occupied by it reduces very materially the capacity of the settling tank and consequently reduces the efficiency of the settling process.

With reference to sludge removal, settling tanks can be further classified into intermittent sludge removal and continuous sludge removal.

INTERMITTENT SLUDGE REMOVAL

Solids deposited in sedimentation basins divide themselves into two general classes. Those of heavier specific gravity settle in the zone near the inlet but do not settle at a uniform depth over this zone. The balance of the sediment, because of its lighter specific gravity and the currents caused by changes of temperature and the velocity in the water, settles more or less uniformly over the rest of the basin. A baffle wall constructed across a settling basin, located one-fourth or one-third distant from the inlet, is very efficient as it prevents the currents in the basin from disturbing and carrying forward the mass of sediment deposited in the first zone of the settling basin.

To facilitate the removal of the sludge, the bottoms of such basins are given frequently considerable slope toward the underdrain openings, so that the sludge can be more readily flushed out through these. Unless there are a large number of settling units, the placing of one of the basins out of service for the purpose of cleaning interferes with the operation of the plant. Furthermore, the necessity for cleaning frequently arises at a time when the character of the raw water is such that sedimentation is most needed and when none of the basins can be spared for cleaning although the accumulated sludge deposits are materially reducing the capacity of the basins. The economy of being able to clean such a basin without having first to empty it is obvious, and with that end in view several methods have been devised.

CONTINUOUS SLUDGE REMOVAL

Two principal types of tanks have been devised in which the sludge can be removed without materially interfering with the continuity of the sedimentation process.

Tanks with Hopper-shaped Bottoms

Such tanks are quite successful and have been used to some extent in water purification plants, but more generally in sewage disposal plants. The principal objection to the more general introduction of the use of such tanks in water purification plants is their high cost of construction. In sewage disposal plants, on the other hand, where the sludge problem is the most important one, because of the great quantity of sludge to be handled, this objection does not hold to the same degree.

Tanks With Perforated Bottoms

A number of sedimentation basins have been built with horizontal perforated bottoms so that the sludge can be drawn off at regular intervals and without materially interfering with the sedimentation process. The writer has built a number of such tanks. The first was built in 1907 in connection with the McKeesport, Pa., water softening and purification plant, which plant has continued in satisfactory service ever since. In this type of tank the sludge removal is accomplished by having the bottom of the settling compartment perforated with circular openings varying in diameter from ½-in. to ¾-in. and spaced not more than 3 feet centers in all directions. These holes discharge into an underdrain system consisting of vitrified piping connected to a common channel. Quick-opening valves located in a pit are used to regulate the sludge discharge. Should the underdraining of the entire basin prove too expensive, the underdraining of the first section of the tank will increase the interval between cleanings fully ten times over that required in a plain sedimentation basin because the greatest percentage of deposits collect in this section of the sedimentation tank. This plan was adopted at Muskogee, Okla.

Figs. II. and III. show the general arrangement of the underdrain system used in the settling tanks at Muskogee. Fig. II. is a section and plan of a portion of the tank showing the arrangement of the underdrain system. Fig. III. shows the arrangement of the sludge valves.

PRINCIPLES OF DESIGN

In designing an underdrained settling basin of the type described a number of precautions must be taken.

Zone System

The underdrain system must be laid out in a series of zones, so arranged that the sediment will be deposited uniformly over the area of any one zone. This is very important for whenever the suspended matter is not deposited uniformly over the area of any one zone, clear water will be drawn in at these openings where the depth of sediment is least, at the time, when sediment may still cover other openings to a considerable depth. Such a condition not only tends to a great waste of water, but is apt to result in the ultimate clogging of perforations, as the operator closes the sludge valve shortly after the discharge shows comparatively clear, not knowing that a considerable area is still covered with sediment.

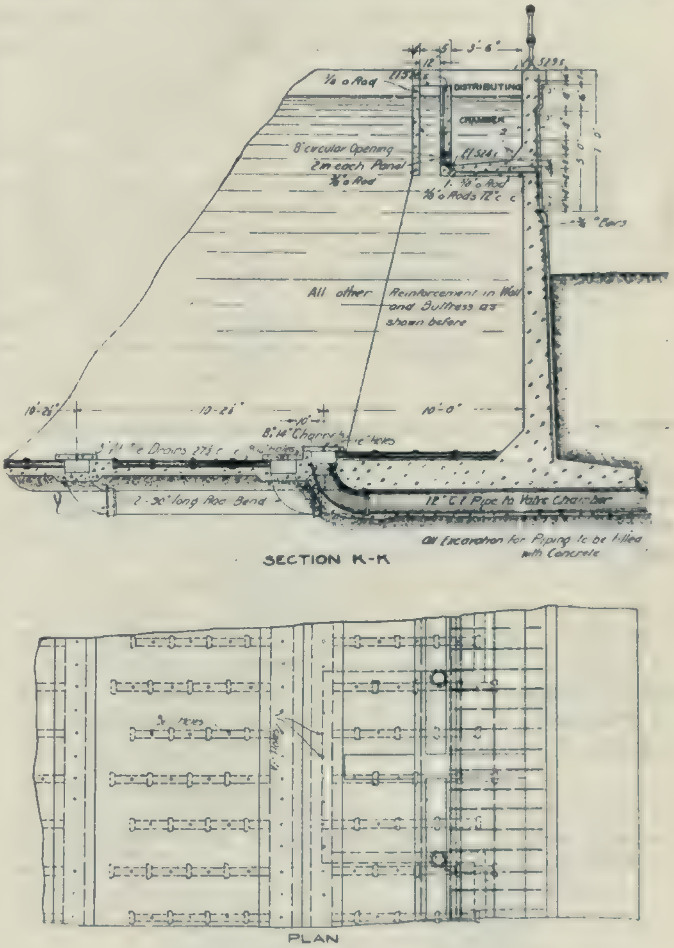


Fig. 2.—Section and plan of portion of tank.

Perforations and Underdrains

The underdrains and perforations must be designed so as to give the same degree of suction over all the

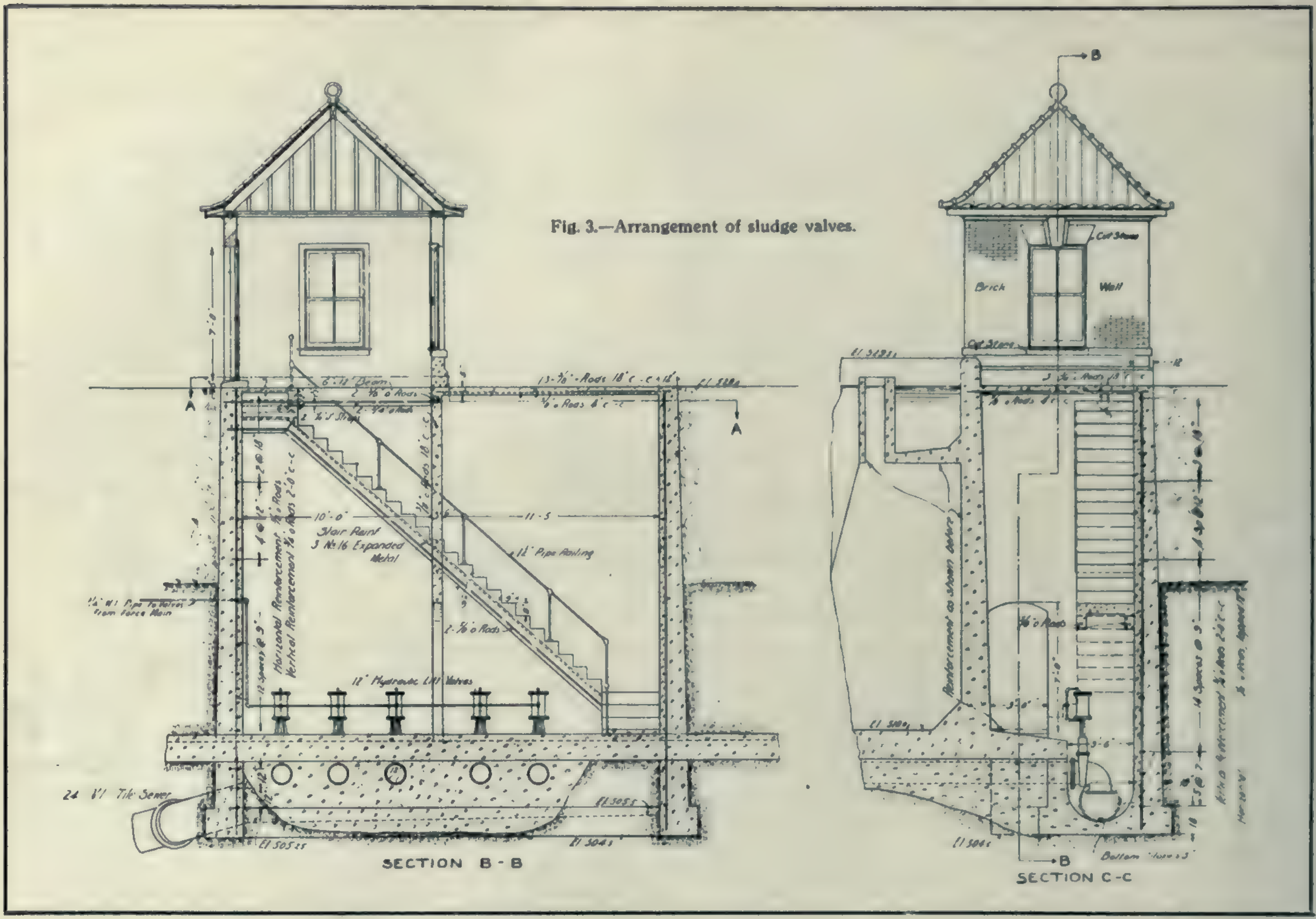
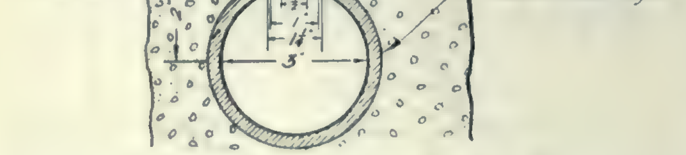


Fig. 3.—Arrangement of sludge valves.

holes in any one zone, otherwise clear water will be drawn in at those openings where the suction is greatest, while sediment may still cover to a considerable depth those perforations where the suction is less.

The total head available for operating such a system of underdrains is the difference in elevation between the water in the basin and the sludge outlet. A head of 10 ft. is ample for operating such a system; with the smaller head every precaution must be taken to reduce to a minimum loss of head at entrance, the frictional loss in the underdrain system and the velocity head at the sludge outlet, so as to be able to utilize as much of the head as possible for creating a scouring velocity through the orifice.



Porcelain drain orifice 3'-0" CC along ℄ of pipe
Top of floor
1½"
Orifice set in 1 to 2 mortar
3" Vitrified pipe in 3'-0 lengths with 1½" holes at centre of each length
1½"
3"

Fig. 4.—Detail of underdrain and orifice.

Fig. IV. is a detail of the underdrain and orifice to be used by the writer at Moorestown, N.J. In this case the underdrains consist of 3-in. vitrified pipe made in sections 3 ft. long in which are cast 1¼-in. circular openings. In these openings are placed porcelain orifices, of the special design shown in Fig. IV., so as to reduce the loss of head at entrance to a minimum.

The underdrain system should be designed so as to keep the velocity at about 4 ft. per second, or less. If the maximum velocity in the underdrains is too high it is impossible to obtain a uniform suction for all the openings in any one zone. The relation of valve area to the openings in any one zone controlled by the valve depends to some extent on the depth of the water in the settling basin. The greater this depth the smaller can be the valve area in proportion to the orifice openings.

When such a system of underdrains is properly designed, there is little likelihood of the underdrains becoming clogged with sediment. The McKeesport plant is now in operation over five years and no difficulty whatever is experienced in keeping the underdrains open and flushing out the sludge.

Bulkheads for tunnel forms are always difficult to build because of the roughness of the rock profile. The Pneumatic Concrete Placing Company, of New York City, which is specializing in tunnel-lining work, has been experimenting to find a suitable way of building such bulkheads quickly and cheaply and has found that cement sacks three-quarters full of sand can be used successfully. The sacks are laid on top of each other in the same way as bricks in a wall and can be fitted into all crevices of the rock, following closely the irregularities of the profile. It is stated that one unskilled laborer placing sacks replaces two carpenters building forms. A bulkhead formed in this way is said to be tight and is left in place the same length of time as a wooden one. When the sacks are removed the concrete surface is rough and gives a good bond with the adjacent section.

Depreciation in Relation to Municipal Works

By R. O. Wynne-Roberts, Consulting Engineer, Regina

IT is noticeable that on the North American continent much attention is now being paid to the question of depreciation of public utilities. One reason for this is the creation of Commissions by almost all the States and the discussion of municipal and other loans in Canada.

A perusal of the voluminous annual reports of the American Public Service Commissions will at once show that depreciation of utilities is being fully considered when rates are revised, whilst in Canada it is sometimes taken into consideration when the subject of the financing of such undertakings is discussed.

Not only are the American Commissions and Canadian authorities paying closer attention to the financing of public undertakings, but there are several public organizations constituted for the purpose of investigating the methods in vogue in Europe and elsewhere, with the view, among other things, of the adoption of the best way to provide for depreciation; and those in control of public utilities are faced with serious problems of rectifying any deficiencies which have arisen owing to the absence of adequate provision for depreciation in the past.

For instance, the National Civic Federation of New York in 1906 sent fourteen gentlemen—each of whom occupied a high position in his own profession—to study municipal and private ownership of Public Utilities in Great Britain. The proceedings of the National Municipal League of America also afford some indications of the trend of public opinion in this matter.

The movement towards municipal ownership is growing. It is advocated strongly by some American organizations, owing to the difficulties which have occurred in many cities due to the granting of franchises for various utilities. The policy of municipal trading has been adopted by many Canadian cities. So long as politics are excluded and capable men are appointed to manage these concerns, there is reason to expect that revenue-producing undertakings can be conducted by municipal departments to the advantage of the ratepayers.

Municipal ownership, however, entails great responsibilies, not only to the ratepayers and the patrons, but also to the investors. "Efficiency and economy" is a useful slogan for special occasions, but to practise it every day is quite a different matter. Efficiency means maintaining a department at a top-notch condition and the service at the same time rendered at a reasonable cost, whilst economy is often interpreted as a reduction of expenses to an excessive degree. This attitude on the part of city administrators is as common in the Old Country as in the new.

Physical depreciation is influenced by these factors in a tangible measure, for if any plant is not maintained efficiently, then its value quickly falls and this in turn affects the investors interests and may also in time raise the price of the commodity produced or the service rendered.

One of the problems which confront the municipal engineer and the municipal auditor is the allowance that should be made for depreciation when preparing the balance sheet of a civic enterprise. Civic enterprises are now fairly numerous and also dissimilar in character. For example, many cities have one or more of the following:—waterworks, electric light works, hydro-electric works, street railways, gasworks, abattoirs, ferries, telephone systems, docks and harbours, high pressure fire pumps, asphalt works, hospitals, schools, etc. In addition to these there are portable machinery of many kinds. The lives of the component parts of the foregoing enterprises vary and each undertaking requires to be dealt with separately.

There are several difficulties to be faced when the depreciation of any plant has to be ascertained. The defining line of depreciation to differentiate it from maintenance, renewals, and repairs is sometimes not easy to establish and therefore each unit must be taken into consideration and the accounts carefully analyzed. The engineer must consequently use his judgment as to what is depreciation and what is maintenance when any expenditure may be allocated to either account.

Actual depreciation and theoretical depreciation are seldom analogous. The actual depreciation of new and substantial plant is small in its early life and increases in after years, but theoretically it is necessary to equalize as far as possible the waste in the value of any asset on each year's operations. The depreciation of reservoirs, dams, docks and buildings will be small and fairly uniform, but parts of electric and gasworks, pumps, street railways, etc., depreciate more quickly and irregularly. Much, however, depends on the character and the extent of maintenance and the care with which the plants are operated. Excellent machinery placed under the control of careless or incompetent men may suffer more seriously than an inferior plant supervised by able men. Moreover some machinery and processes are liable to be changed owing to unanticipated developments and improvements, long before the expected life has been exhausted. In other works obsolescence and supercession should in many instances be provided for. Apart from depreciation, etc., there are occasions where reserve funds would be very useful, for it is unwise to increase the loan debt when by judicious building up of a reserve fund many contingencies may be met. This has been done in many places. A portion of the income in good years is set aside to build up a reserve fund up to a maximum of say twenty per cent. of the total capital expenditure. Such a fund is available to meet deficiency in the income of the undertaking or to pay off extraordinary claims or the cost of reinstating certain works destroyed by fire, accident, or which have become inadequate or obsolete. The city of Leeds (England) obtained powers in 1905 to create a reserve fund on the above lines, and the British Model Gas Bill as amended in 1913 has a provision for the same object.[1]

Every prudent municipal financier will endeavor to arrange that civic enterprises will each year bear their own fair share of liabilities, such as depreciation, etc., or arrange for the period of repayment of the loans to be equal to the equated life of the plant for which the money has been obtained.

When any city has expended on new works to the full extent of the power granted by law, then in Great Britain "any further borrowing power required to replace obsolete assets or outlay before the original loan is repaired have to be granted by Parliament, and

---

(1) Gas World, Feb. 28, 1914.

very severe scrutiny is made into all the circumstances because the grant of further powers will lay a double burden upon the community until the original loan is repaid. All this tends to support the present practice of Parliament, namely to fix the period of repayment at a number of years well within the life of the asset; in other words, to make the annual charge for the redemption of debt a little more than equivalent to the normal rate of depreciation which could be charged to revenue, or profit, and loss, account by a prudent trader?'"[2A]

When loans are obtained for longer periods than the actual or equated life of any plant, then the question is how to provide for the liabilities already mentioned. This is a matter which requires careful consideration for on this depends the adequacy or otherwise of the funds.

In Great Britain the Local Government Board decides the period of repayment of municipal loans and these are fixed according to the nature and quality of the works for which the money is required. Omnibus loans are not usual, that is loans for a variety of works having a great range of durability are not usually added together. For instance, a waterworks scheme may include land, masonry dams, reservoirs and mains, pumping machinery, meters, etc. The probable life of each component part is different and the period of repayment therefore varies. A street railway scheme will ordinarily comprise land, power plants, buildings, rails, wires, cables, poles, cars, etc. The expected life of these may range from a minimum of say six years to a maximum of any number of years, for land usually will not depreciate. Loans are either sanctioned for each item so as to secure the maximum period of repayment in each class, or the life of the composite scheme is ascertained and loans sanctioned for such periods. The results in these cases is that depreciation is ordinarily covered because the entire cost of the plant must be repaid in the estimated life of the plant and consequently the risks to the investors are reduced and they are prepared to accept a lower rate of interest.

In the United States, loans are sometimes negotiated and the number of years in which they have to be repaid are fixed regardless of whether the works involved will have an equal life. When any part of the undertaking has become distressed by wear and tear, or has become inefficient or inadequate or obsolete in a less time than the period for which the loan has been contracted, then another loan is often obtained and the utility has to carry more capital than it should legitimately be charged with. This has gradually created a situation that is neither satisfactory to the public nor the investors, hence the reason for the creation of about 43 State Commissions to control this matter.

In Canada, there is tendency towards American methods of financing utilities. There are instances where the cost of certain works and machinery have been distributed over a period during which renewals will probably occur more than once. If the public authorities charge such renewals to revenue, or if a reserve fund is created to bear the cost of the same, there can be no serious objection, although it would be better to fix the time for the retirement of the loans equal to the life of the plant. If on the other hand any plant, appliances or machinery which become worn out before the repayment of the loans and there are no funds other than a fresh loan to meet the cost of such renewals then the utility is not operated on good sound financial basis, and this may in time operate to the disadvantage of the utility.

The Local Government Boards which will sanction municipal loans and Public Service Commissions for other public utilities, will no doubt inquire into applications for authority to borrow or issue bonds and thus safeguard public credit. In this connection it will be useful to quote Wall Street Journal:—

"There are few States in which Public Service Commissions have not been established by law, and while there was a time when they were looked upon as hostile to the capital invested in the companies, it is beginning now to be realized that they tend in actual practice to protect the companies as well as the public. The regulation by commissions is protecting the security of the investor in public service bonds and stocks. They offer one of the most inviting forms of investment that can be found." The article is too long to quote fully. "These bonds suffer less than any other class from the periodic reactions in general trade," is the testimony of Mr. Lawrence Chamberlain in the same Journal.

Having regard to what has been stated, it will be apparent that where works are executed and the equated life of the same do not correspond with the period of repayment, then it is reasonable to suggest that depreciation should be provided in some way to make up the deficiency.

"Investors in public utilities at least under normal conditions are entitled to have their investments kept intact. If they are not within reasonable limits assured of this the necessary capital will not be forthcoming. These conditions prevail regardless of whether the plants are privately or publicly owned."[3]

"The term depreciation, though not strictly accurate was originally applied as a convenient form of expression of the phrase 'diminution of value due to wear and tear.' It covers, however, other and wider contingencies. The question of depreciation cannot be separated from that of maintenance, and in theory one may be said to balance the other."[4]

"Depreciation is generally due to causes which may be classified under ordinary wear and tear, general decay, obsolescence and inadequacy."[3]

"Depreciation is concerned with the allocation to each year's operating accounts of the waste in the instruments of production attributable to the year's operations. The cost of materials purchased and entirely consumed in the course of the year's operations is invariably included in ordinary operating expenses."[5]

The question often arises as to the method by which depreciation should be provided, whether by equal annual amounts, by sinking fund, by annuity, by uniform annual investment charge, by Dollar-year method or some other arrangement. This is a matter for the Engineer and the Accountant to consider. There are strong advocates of each method. The Wisconsin Railroad Commission and other Commissions generally adopt the straight line method of equal annual instalments, that is, the original cost of the plant, less its estimated residual value at the end of its life, is divided into equal annual payments to the fund. The sinking fund method is largely used in Great Britain and by many authorities on this side of the

---

(2) Repayment of Local Loans, by Edward Hartley Turner, 1913.

(2A) See Report of Select Committee of British House of Commons, 1902.

(3) Address on Depreciation, by Mr. Halford Erickson, of the Wisconsin Railroad Commission, 1912.

(4) Depreciation, by Ewing Matheson, 1910.

(5) Depreciation and Public Service Regulation by R. W. Witten. Engineering News, May 8th, 1913.

Atlantic. Amounts are set aside annually and invested in some approved securities or used in building extensions, etc. These amounts placed at compound interest will in the aggregate be equal to the cost of the plant less its scrap value. The annuity method consists of setting aside a sum for repayment, and interest, which together are the same each year, but as the interest decreases the repayments increase. The uniform annual investment charge is fully explained by Mr. Whitten in the Engineering News. It is assumed that the depreciation reserve is invested in the undertaking, and becomes an integral part of the investment. It is practically the same as the sinking fund, except that the latter fund is usually invested in other securities at a different rate of interest to the rate of return from the business the capital of which it will ultimately repay. The dollar-year method involves the classifying of various parts of a plant according to their durability, and then the number of times each class of machinery, etc., must be renewed in the life of the most durable class is ascertained. The total cost of all the renewals in each class during the life of the longest is computed and these costs multiplied by their lives will give the total dollar-years. When the total dollar-years for all classes is divided by the total cost of all renewals during the period then the quotient obtained represents the composite life of the plant.

The New York Electric Railway Company provide for maintenance and depreciation combined by setting aside a sum of money based on car mileage; other companies deduct a percentage on gross earnings. Some electric light and power authorities base the renewals and depreciation on the monthly output in kilowatt-hours. Other companies having a large and permanent plant are able to dispense with the depreciation charge because there is a wide annual average deterioration on the whole plant and the annual expenditure on renewals maintain the undertaking at approximately a constant value. For instance, in a concern where a large number of boilers, engines and generators are operated, instead of creating a depreciation or reserve fund any boiler, engine or generator becoming inefficient is scrapped and replaced by a new and better unit, out of revenue.

In smaller undertakings—and these constitute the major number of undertakings and involve a large investment in the aggregate—it will be possible to find funds to meet renewals, replacements, depreciation, only by an annual or more frequent contribution made out of revenue to provide for such purposes.

Caisson Type of Infiltration Reservoir at Sarnia, Ont., Waterworks

By H. A. McLean, Town Engineer, Sarnia

NO municipal undertaking contributes more to the comfort and well-being of the residents than the development of a pure water supply. Sarnia is just now completing an entirely new plant which medical and engineering experts affirm will furnish "the best water in the world." This plant is located where the waters of Lake Huron enter the River St. Clair. It consists of the pumping station, infiltration reservoir and force main.

This main is over two miles long and enters the present supply main of Sarnia at the corner of George and Front streets. It is 24 inches internal diameter and is 5-16 inches thick. The steel is made by the Siemens-Martin Open Hearth process and the pipe is lap-welded. The minimum lengths are 26 feet and the joints are of the bell and spigot type. The joints average 5¼ inches long and are caulked with 3¾ pounds of oakum and 45 to 50 pounds of lead. The bell is reinforced by turning a flange on the pipe 1½ inches in width. To protect these pipes from corrosion they are dipped when at a temperature of 300 degrees Fahrenheit in a rust-resisting solution of the same temperature. They are then wrapped in burlap and re-dipped in an asphalt solution. This insures a double coating for the inside of the pipe, while the burlap serves the double purpose of holding the solution on the pipe and of being a protective coating. After being caulked, the joints are coated, wrapped with burlap and recoated with the solution. The pipe weighs 85 pounds bare and 88 pounds coated and wrapped.

The main is furnished at intervals with valves of the Ludlow type and is laid so that connection may be made for the village of Point Edward through which it passes. Two expansion joints serve to take care of expansion and contraction and also to facilitate making connections to the pumps and to the present mains, Special Y's are also laid in the main to allow cross connections being made when it becomes necessary to lay a duplicate main. The contract price for laying the main is $2.25 a foot and for the pipe itself $3.62½ a foot.

The power-house is situated on the beach of a bay where the tendency of the current is to build up the land. It consists of a coal room, boiler room and a pump room in which are the office and store room.

The coal room is 40 feet long and 42 feet wide and has a switch running to it. Two large sliding doors permit a car of coal being shunted right into it. No coal-handling device will be installed just now, as the boilers will be fired by natural gas piped from the Tilbury fields on the shore of Lake Erie, sixty miles distant. However, coal hatches in the roof have been provided to permit coal being unloaded from the vessels if the gas supply fails. A supply of coal will always be kept on hand in case of an emergency. The room is built of pressed red brick outside and common red brick inside, well reinforced with steel bands, and has a concrete floor and a concrete roof supported by steel trusses.

The boiler room, which is of pressed red brick both inside and out, is 45 feet long and 42 feet wide and is equipped with a battery of three boilers of 500 h.p. capacity. These boilers are of the return tubular type and are manufactured by the Waterous Engine Works. They are 72 inches in diameter and 18 feet long, built in accordance with the boiler regulations of the province of Ontario for a working pressure of 150 pounds and a hydrostatic pressure of 225 pounds a square inch. Each of these has 72 tubes, 4 inches in diameter, and the total heating surface of each boiler is 1,555 square feet. The grates are shaking grates, 66 inches long and 66 inches wide, and these are installed as gas requires a net-work of fire brick to break up the gas jet. Otherwise the flame would shoot

Lowering pump wells.

First chamber of basin in place.

through the tubes and up the stack, thus imparting very little heat to the water in the boilers.

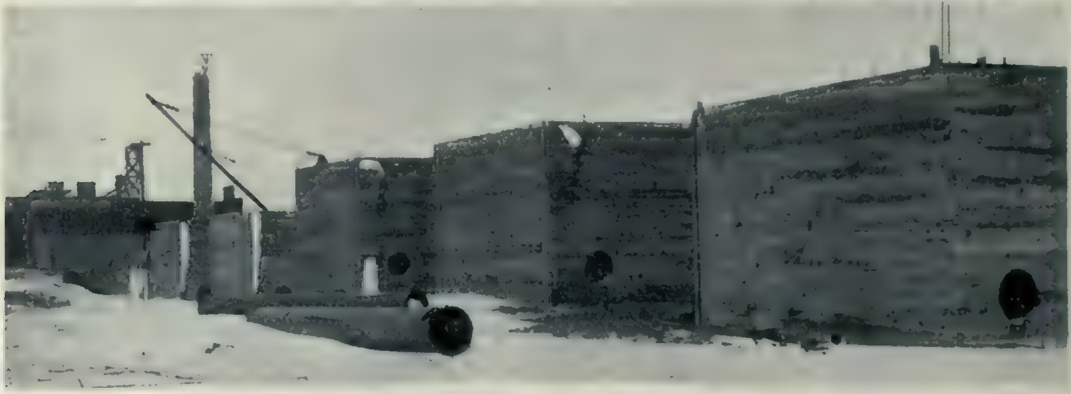
The smoke stack is 100 feet high and 4 feet 6 inches in diameter. It is built of radial fire brick on a six-foot concrete foundation, 24 feet square. It is built on a compact bed of sand and gravel capable of sustaining a weight of 1½ tons a square foot. It is built by the Alphons Custodis Construction Company, of Chicago.

The pump room is built of pressed red brick outside with pressed buff brick inside and is 64 feet long and 50 feet wide. In it will be installed a duplicate set of turbine pumps driven by steam turbines supplied by the Canadian Allis-Chalmers Company, Toronto.

The rated capacity of the steam turbines is 250 h.p. each at 3,600 r.p.m. when operating under the following conditions: (a) steam pressure at turbine 150 lbs. per guage; (b) superheat at turbine 0 degrees Fahrenheit; (c) back pressure 0 lbs. per guage; (d) vacuum at turbine reduced to 30 inches; barometer 28 inches mercury.

The turbines are of the impulse type with two complete stages and are designed for direct connection to the pumps by means of reduction gears. Operating condensing the steam consumption, exclusive of that used by the auxiliaries, is 15 pounds per b.h.p. hour at full load.

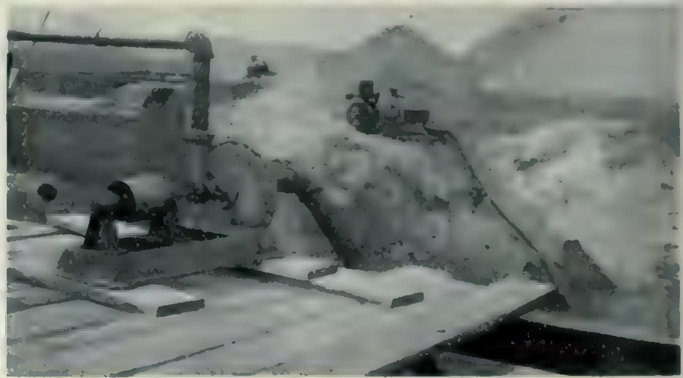
Each turbine has a set of double helical reduction gears capable of reducing the speed from 3,600 r.p.m. down to 1,450 r.p.m. and is capable of safely and continuously transmitting 260 b.h.p.



Chambers of basin ready for lowering.

The pumps are high lift single stage turbine pumps of the Mather and Platt design and are capable of delivering 3,000 imperial gallons a minute against a total head of 199 feet, including a suction lift of not more than 22 feet when running at a speed of 1,450 r.p.m. The power required by each pump is 230 b.h.p. The suction pipe is 22 inches in diameter and the discharge pipe from each is 14 inches. The guide or

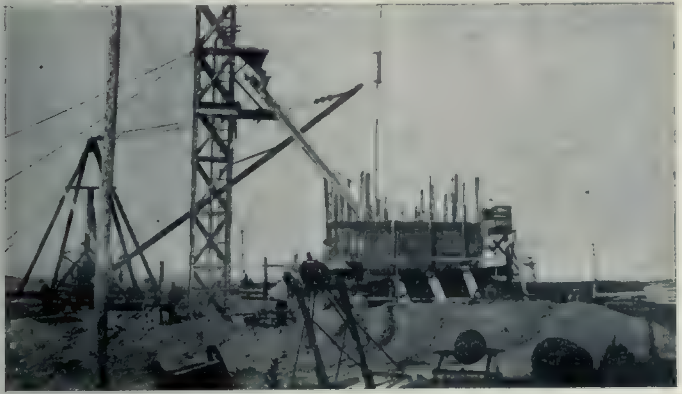
Lowering basin and section.



Testing filtration of water through different strata.

diffusion vanes are made of phosphor bronze and are removable and easily replaced. The impellors are also made of phosphor bronze and are of the enclosed type. Removable neck rings are fitted on each side of the impellor to prevent leakage of water back to the suction port of the impellor. Each pump is designed to pump 4 1-3 million gallons per 24 hours against a pressure of 86 pounds for domestic service and for fire service to pump six million gallons against a pressure of 120 pounds. Each set is designed to amply take care of the ordinary consumption and one is a duplicate of the other. For fire consumption, however, the pumps are run in series. This arrangement gives the most economical results, a saving of 10 per cent., as the water-works system is a direct pressure system and the full load capacity of the pump is more nearly attained than in any other way. The bed plates and shafts are so constructed that motors may be installed later on if Sarnia adopts the use of Niagara power.

The condenser is a surface condenser of the waterworks type and is installed on the suction pipe. The water is drawn through a bank of condensing tubes and is pumped directly into the force main. As this main lies in a water-bearing stratum the temperature of the water delivered to Sarnia consumers will be the same as if any other type were used. The condensed steam is returned to the heater by a 6-in. x 14-in. x 10-in. single acting Edwards air pump installed in the condenser pit.



Method of pouring concrete. Sarnia waterworks.

A 24-inch Venturi meter tube is installed in the force main just outside the power house and a type M. Register, Indicator Recorder is installed in the pump room.

Two pump wells, 25 feet long, 8 feet wide and 22 feet deep, are located underneath the pump room and two just outside. These are built with reinforced concrete bottoms and are so constructed that the power house may be extended at any future time as the consumption increases.

The infiltration basin is built in twenty sections 25 feet square and 19 feet deep. These sections extend 18 feet below the water level. A concrete building 6 feet high extends over all and the two pump wells besides. This is equipped with a ventilator and manhole for each section, and a steel gallery 3 feet wide resting on the top of the section runs the whole length.

The basin is constructed 100 feet from the shore line in a bed of gravel 60 feet deep and this forms the bottom of the reservoir. The water percolates through this bed into the basins. As the current in the River St. Clair at this point is from 5 to 8 miles an hour the gravel is kept continually washed free of all silt. This method of slow sand filtration has been approved by the Ontario Board of Health and saves Sarnia $100,000 in initial cost as well as the cost of washing the sand, if any other sand filtration plant were installed.

In constructing this basin and pump wells, each alternate section is built above the water line and allowed to stand until thoroughly seasoned. Then the gravel is excavated from the inside by means of a clam-shell bucket dredge. The section settles down as the gravel is excavated until it reaches the proper level. The bottom is then made up of a layer of stones not exceeding 2 inches in diameter. For the intermediate sections concrete slabs are built which overlap the basins on each end. These have grooves moulded in each end which correspond to similar grooves in the sections previously sunk and are sunk in exactly the same way. Each end of the slabs and the basin has two-inch wooden rubbing strips 1 foot wide secured to the concrete by bolts to decrease slipping friction. When all are in place the grooves are tamped full of concrete to form a water-tight joint.

A steel pipe with a 24-inch valve in each section extends through the basin and pump wells so that the flow from each may be regulated. These valves are operated by a hand-wheel from the steel gallery.

The cost of the plant is as follows:—Force main, $87,000; power house, $33,000;; infiltration basin, $65,600; boilers, etc., $7,000; pumping machinery, etc., $22,000; engineering, etc., $12,000; total, $226,600.

A recent survey has demonstrated clearly what was previously considered probable—the practicability of constructing a bridge on the rocky reef called Adam's Bridge, which connects the island of Ceylon with the mainland of India. The distance is 22 miles, and an estimate has been made giving the cost of the work, which probably includes a good deal of causeway, at about $4,000,000—an amount much less than was previously thought necessary. There is, therefore, a probability of this important connection being carried out in the near future. A part of it, from the main land to the island of Rameshwaram, has in fact been built. The immediate utility of such a bridge is much diminished by the fact that while the main-line railways are uniformly of 5-ft. 6-in. gage, the gage of the Adam's Bridge branch is narrower. Hence the excellent harbor at Colombo would still lack suitable connection with the rest of India.

A company of British engineers and others interested in Canadian transportation were entertained at dinner in the Savoy Hotel, London, Eng., on April 30 by the Montreal Harbor Commissioners, of whom Mr. Cowie, the chief engineer, acted in the capacity of host. Referring to the investigation being made by the Commissioners, Engineer Cowie said they were inspired by the competition and also by the investigation of Canada's rivals for European trade. On the other hand, the economical working of the port in Montreal had attracted engineers from Europe and America.

Mr. Hugh L. Cooper, of Rochester, Minn., builder of the big dam across the Mississippi river at Keokuk, Iowa, has been appointed by Sir Ralph Wilcocks, supervising engineer of the famous Assouan Dam, as consulting hydro-electric engineer for the Egyptian Government. Mr. Cooper will have supervision of the construction of the dam across the River Nile, which it is said will be one of the largest dams in the world.

A Retrospect of Municipal Engineering Practice in 1913

By the London, Eng., Correspondent of the Contract Record

MUNICIPAL engineering practice covers such a wide field now that it would be difficult to deal, within the compass of a readable article, with the entire range of subjects embodied in the expression. Some line must be drawn, if the article is not to become heavy and unwieldy, and it is therefore proposed to retrospect only so far as highway construction and maintenance, water supply, sewage disposal, (which may be taken to include sewerage) and refuse destruction are concerned. These are the primary duties of a municipal engineer, and apply equally whether he holds an important borough appointment or is merely the "surveyor and inspector" to a small urban or straggling rural district. Such works as those in connection with housing, hospitals, schools and so forth, call for architectural training and experience, and although duties in connection with them are frequently added to those legitimately his, the services of an outside architect (except possibly in the case of county schemes) are often requisitioned either to do all that is required or to co-operate with the engineering official. The past year has witnessed the completion of many large schemes, but individual reference to these will not be made, a catalogue being quite a different thing from a retrospect.

Highway Construction and Maintenance

It is customary in considering this subject to commence with some such expression as "the rapid development of self-propelled traffic during the past few years" or "the wear and tear caused by high-speed mechanical traction," and to point as a moral the numberless problems which have confronted the engineer in his endeavor to cope with such disturbing elements. The one thing that is certain is that the highway engineer has been placed upon his mettle by the new traffic, and that the methods of the erstwhile road-foreman-surveyor have had to go by the board.

The International Road Congress

The most important event of the year 1913 was undoubtedly the International Road Congress held in London. Here were collected data and statistics relating to highway engineering and administration in all parts of the civilized world, and if the number of papers was excessive and the treatment of the various subjects was occasionally diffuse and the translations left something to be desired, there was yet a residue of good sound stuff which well repaid study—especially when served up in the condensed form adopted by the Contract Record.

Terminology and Classification

Terminology was one of the matters dealt with in the Congress papers, and a tribute must be paid here to the admirable glossary (reproduced in the columns of the Contract Record) which has since been prepared by Mr. Percy Boulnois. That there are faults in the glossary and that it leaves out much that should be included and includes much that is redundant, does not militate against its usefulness. The criticism it has aroused is the strongest evidence that could be adduced in its favor, and when the glossary appears finally in book form it will, there can be little doubt, prove itself one of the notable achievements of 1913, its year of inception. The classification of the chief road stones, undertaken by the Engineering Standards Committee on Road Materials, deserves at least passing mention as being the inaugural step towards a complete classification of materials. The subject was dealt with in an article, "Standardization of Road Stones and Standard Nomenclature," which appeared in the Contract Record of October 1st last.

The Road Board Trials

A great flourish was made at the International Road Congress regarding the trial sketches of various forms of road construction which were laid, under the supervision of the Road Board, at Sidcup and elsewhere. Many visitors were deluded into visiting the site and the motor omnibuses on the favored routes did a roaring trade. Optimists have expressed the conviction that the present year may bring to light some practical results from these trials, but the practical man (who is not necessarily pessimistic by-the-bye) is of a different opinion. It may seem a harsh thing to say, but these belauded trials can no longer be regarded in any other light than that of a huge joke. That they were well-meant none can deny, but good-meaning and incompetence only too often go hand in hand in this life, with regrettable results. An interim report of these trials was issued by the Road Board last year, but it was for the greater part valueless. Some of the materials laid have since had to be relaid, many of them have had to be repaired, while in some instances (in one at least) one material has been replaced by another. Unsuitability for the traffic conditions obtaining on the trial stretch must be the final report as to quite a large proportion; indeed the matter could now be decently interred and put away from sight and memory for ever without a pang of regret from any sane-minded individual.

Road Engineering

Road engineering, in the true meaning of the term, does not exist in England. What undeveloped tracts of country there may be are not in the market for development, and the supply of roads is in the main fully adequate to meet requirements. New roads come into being only in the case of estate development and present neither engineering features nor difficulties. There are certain road schemes for London being discussed now, notably the western approach road to London and the Croydon relief road, and both of these will certainly fall within the category of engineering works, but they are the exceptions and—they are only schemes at present and have not yet materialized. The extension of town planning will doubtless in time call for the construction of many important highways, but town planning is not making much headway against the red-tape restrictions and harassing requirements of the Local Government Board. There is no greater anomaly than the number of Acts which are passed by the Legislature only to be rendered null, void and of no effect by the very Departments and officials created to popularize them and assist their working. A rapid descent in the scale must now be made to

Road Crusts and Carpets

and the question naturally arises, why not "linoleums" and "oilcloths," having regard to the oiled and similar surfaces that abound? It may be said at once that the year 1913 has brought nothing new in either good crusts or carpets. There has been an enormous amount of nonsense talked on the subject, with just a leavening of real commonsense, and one contemporary in particular has been feeding its readers almost entirely upon road crusts. That the subject has its importance it is unnecessary to say, but it has its limits, and there are other subjects that deserve at least some slight share of attention. When a writer descends to measuring the depth and area of the pittings made upon a road crust by rain, it is very nearly time for the operation of some Mental Deficiency Act in his case. There are three primary methods of surfacing a macadamized road: Surface painting, tar macadamizing and pitch grouting. Other methods are variants of these, as are the numerous proprietary systems, such as pitchmac, tarmac, rocmac, ferromac, lithomac, cormastik, plascom macadam, roadoleum, and tarvia. There is no doubt something in all of them, and improvements are made in their composition and laying as experience is acquired; but nothing of a startling nature has been accomplished in this way during the past year, owing, it may be, in some instances, to perfection having been obtained! At least, so we are told in more than one catalogue issued for the coming season. As regards tar painting and tarred materials in general it must be noted that the increase in the cost of tar is becoming a serious matter. Its price is several times what it was in the early days of these systems, and unless some other material comes to hand the cost of such work must become prohibitive. There have been no noteworthy improvements in road machinery since the exhibition which was held in connection with the International Road Congress, although some interest attaches to the three-axle roller designed by Colonel Crompton. This roller is designed to give pressure ranging from 160 lb. to 500 lb. per inch width of roller.

Town and City Roads

Tar macadam is being used in vastly increasing quantities in residential quarters and in business streets where the traffic is fairly light. The tendency to substitute granite setts for wood and asphalt pavements in busy thoroughfares has become more marked during the past year, but there have been no actual conversions worth recording. In wood paving creosoted soft woods chiefly are employed, to the possible exclusion in time to come of the Australian hardwoods. In quarters where the motor traffic is heavy, such work has had to be done in strengthening the foundations of the roadways, and this has been found to result in a saving of maintenance costs. Brick pavements have not yet caught on and their use is practically confined to footways, channels and crossings. The use of rock asphalt has increased much during recent years, and last year formed no exception.

Water Supply

Among the more important events in water engineering the installation at Chingford of the Humphrey pump by the Metropolitan Water Board must occupy a prominent place. The pump is of the internal combustion type, in which the explosion of gas takes place in direct contact with the water to be lifted, and upon which it exerts the force necessary for raising it. The Board, after a most thorough investigation, decided to adopt this pump, and the installation at Chingford has a total capacity of 180,000,000 gallons per 24 hours, with a lift of from 25 to 30 feet. Five pumps have been erected in all, four with a 40,000,000 gallon capacity and one with a 20,000,000 gallon capacity per day. The column of water in the "play-pipe" oscillates to and fro according to the stroke of the pump, and a large conical water tower above the outlet makes good the fluctuating levels of the water, and so maintains a continuous discharge to the high-level reservoir. Anthracite coal is used for the producer gas, with a guaranteed consumption of 1.1 lb. per actual water horse-power, and with this at 22s. per ton the fuel cost of pumping would be .0196d. per 1,000 gallons lifted.

Water Purification

Under this head there is nothing of a definite nature to record. The good work is forging steadily along, and advances have been made both in purification and sterilization of water by the use of chlorine, by treatment with hypochlorite, ozone and the ultraviolet rays of light, and by mechanical pressure, filtration and oxidation. It would be superfluous to deal with these in detail, all the processes having received a due share of attention in the Contract Record and other technical journals during the past year. A great deal of attention has been paid to treatment with lime, for softening, sterilising and purification purposes. "It is evident," says an authority on the subject, "that lime is not only useful for softening water; it is useful also when added to water containing carbonic acid in neutralizing the acid and in removing plumbo-solvent qualities; further, if added in proper proportion, it will prevent the corrosion of iron pipes, it being found that the thinnest possible film of lime acts as a preservative." Mr. G. C. Whipple, in a paper read before the New England Waterworks Association, dealt with the addition to plumbo-solvent waters of lime in the form of powdered chalk. The manufacturers of softening plants are now claiming the merit of sterilization for their processes. The Metropolitan Water Board is still pursuing its researches, under the able direction of Dr. Houston, into the purification of water by sand filtration and storage. One week's storage is said to increase the safety of the water over a hundredfold, while the uniformity obtained in the quality of the stored water assists the efficient working of sand filtration beds.

Mains and Structures

The causes of the incrustation of water mains and of animal and vegetable growths in water mains have received considerable attention, as has also the subject of external corrosion. Steel mains are coming to the front, although the demand of the Local Government Board for repayment within a short period of loans for these mains has restricted their use. A great amount of steel pipe is exported from this country to the Colonies. Reinforced concrete is another material for which the Local Government Board will not grant long-period loans, with the result that its use for reservoirs and other waterworks structures has been considerably curtailed. An important report on the subject of cracks in reinforced concrete has been drawn up by the Concrete Institute. It is interesting to note that water may in swimming baths be used over and over again if properly purified. The

Belfast Corporation had, in July last, a public bath which had not been completely emptied and refilled for seventeen months, only sufficient water to make up for loss having been added from time to time. Bacterial analysis showed the water to be as pure as the town drinking supply.

Sewage Disposal

In his presidential address delivered last year before the Association of Managers of Sewage Disposal Works, Dr. Bostock Hill laid stress upon the necessity for co-operation between the chemist, the biologist and the engineer, and in this direction much has been done during the past year. The problems of sewage disposal have proved to be of a highly complicated nature, and it is being realized, none too soon, that there is no royal road to the disposal of sewage, each individual case calling for special treatment. There are adherents of slate beds, septic tanks and so forth, who claim practically their all-sufficiency, but any such claim is sheer nonsense. The past year has been one of steady progress, of grappling with difficult problems, of trial and experimentation galore; but the finger cannot be laid on any specific performance of outstanding importance. The literature on the subject has been voluminous, and a number of huge schemes—notably those of a joint sewerage scheme for Greater Vancouver and for Greater New York respectively—have received their due share of consideration.

Royal Commission on Sewage Disposal

The Appendix to the Eighth report of this Commission was issued during the year, and the event must have a certain amount of importance. It is unfortunate that the Commission has been so long in issuing its reports, as the first must of necessity be more or less out of date long before the last appears. The Appendix contained a mass of information, together with records of practical investigations; and must prove very useful to the engineer who has time to study it. Possibly when the next report (which is to be the final one) has been issued, an intelligent and intelligible precis of the whole of the volumes may be looked for. It will be possible, perhaps, to boil them down into the compass of quite a small book. In America investigation of every kind is proceeding apace, and records are being made and data established that puts into the shade the work done in any other country.

Dilution

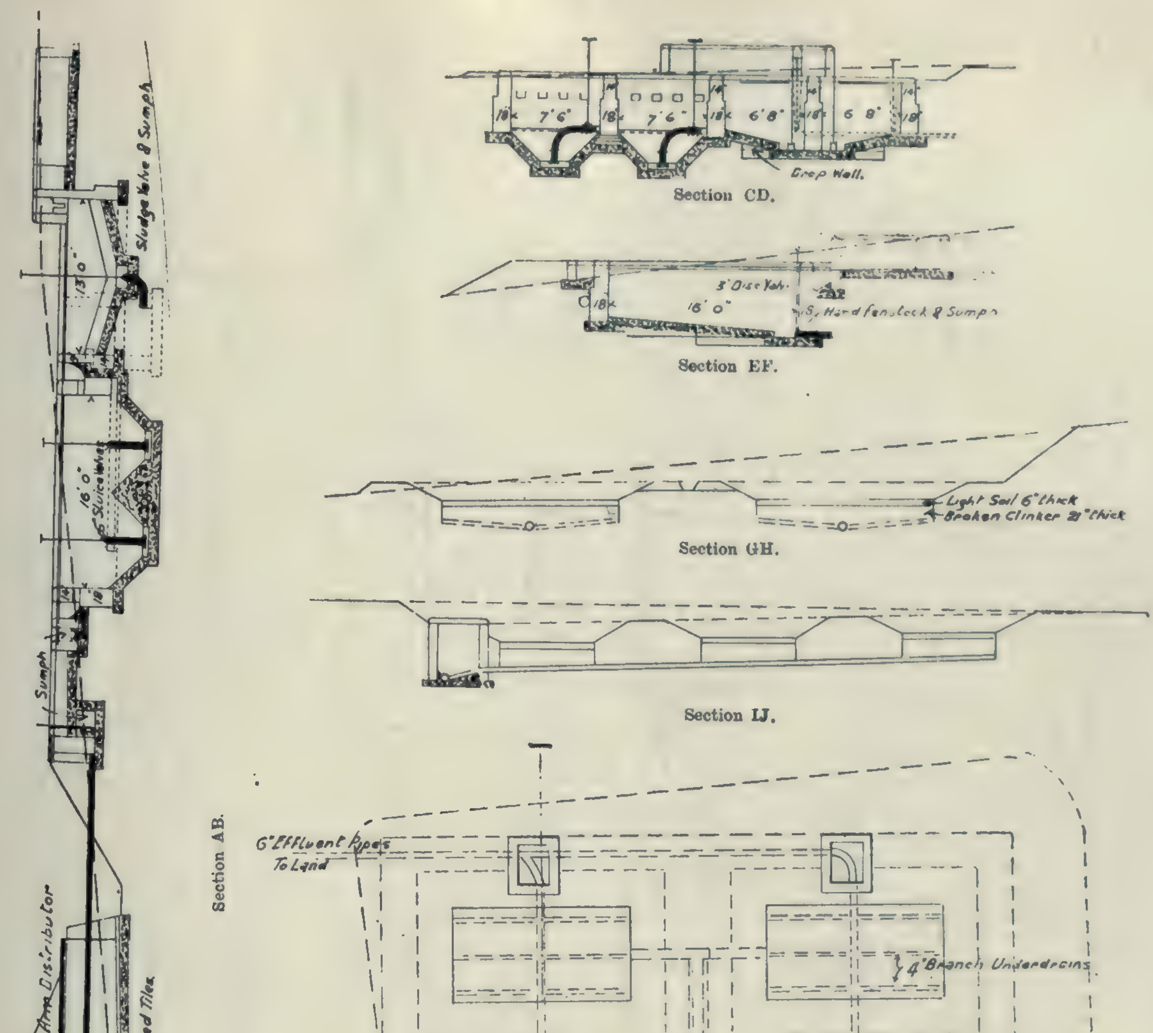
The question of disposal by dilution has been largely discussed but it has not found much favor in England. The Royal Commission on Sewage Disposal did, in its Eighth Report, extend its patronage to it, when the dilution was not less than 500 to 1. "The ratios of dilution recommended as the chief factor to be considered in dealing with settled sewage appear," says an authority on the subject, "to be perfectly safe." These observations are based upon the records of experience in America, where crude sewage has been discharged into large bodies of water where the volume, as in the Great Lakes or in New York Harbour, has been ample, but the lack of suitable currents has had the effect of causing the deposition of heavier solids in large quantities or the drifting of the lighter floating solids into positions where they have created a nuisance. Even in otherwise well regulated streams the unavoidable slackness of flow at the sides, or in weir-pools and in very dry seasons, has also caused the suspended solids to be deposited in such quantities as to form large accumulations of putrefying organic matter, which has inevitably given rise to serious nuisance in the form of objectionable smells, as well as exhausting the dissolved oxygen in the water and thus rendering it unfit to support fish life." One cannot agree with Mr. G. W. Fuller, a member of the American Society of Civil Engineers, who considers that a 45 to 1 to a 90 to 1 dilution, depending upon the manufacturing wastes in the sewage and the dissolved oxygen content of the diluting water, would be sufficient to prevent nuisance to sight and smell, although where the bulk of the solids in suspension had been previously removed some such standard of dilution might suffice.

Methods of Treatment

There is nothing sufficiently novel in the methods of treatment obtaining to call for special notice. Dr. Bostock Hill, in the address already mentioned, definitely expressed himself as in favor of circular percolating filters, of a standard depth of 5 ft., with material about one-half inch in size, although a little finer on top. It is too early yet to pronounce finally upon such details; but the one fact remains that, in this country, although contact beds continue to give good effluents preference is given in new works to percolating beds. The fixed spray jet is being largely adopted in America for percolating beds. Simple land treatment in England is dead, the Local Government Board not being prepared to entertain proposals for broad irrigation, no matter what amount of land it may be proposed to allot for the purpose.

Sludge Disposal

Sludge disposal still receives its meed of attention, but it remains a very acute problem indeed, and is the cause of more trouble to the engineer than any other feature of sewage disposal. The conversion of sludge into a saleable manure that will pay for the labor expended upon it seems beyond the reach of practical economics for the present. In May last, Dr. Grossmann, of Manchester, read a valuable paper on his system of sludge disposal. Sludge, he pointed out, contained nitrogen, phosphates, potash, all good for plant food, and yet it was not a good manure owing to the presence of grease which prevented the access of air and water to the soil, and also rendered impossible the solution by rain of the valuable ingredients. In his system (which has been working satisfactorily at Oldham for some time) the grease and certain solids are removed, leaving a valuable dry powder of high manurial value, portable and easily handled. Unfortunately, he cannot claim a profit on the process, but he is prepared to undertake that the cost of getting rid of the sludge altogether would not be more than the present cost of converting it into pressed cake. In America the Imhoff tank has found great favor. The tank is designed to reduce the bulk of the sludge and to digest it down to an easily handled residue of an earthy nature suitable for manure. Important developments in sludge disposal may safely be looked for in the course of the next few years. When once commercial enterprise enters the field, it is pretty obvious that there will be some practical results, and already several companies are making arrangements to take over the total output of sewage from selected works for the purpose of utilizing it in various ways. Dr. Grossmann's is a case in point, and others—the Native



Section CD.

Section EF.

Section GH.

Section IJ.

Section AB.

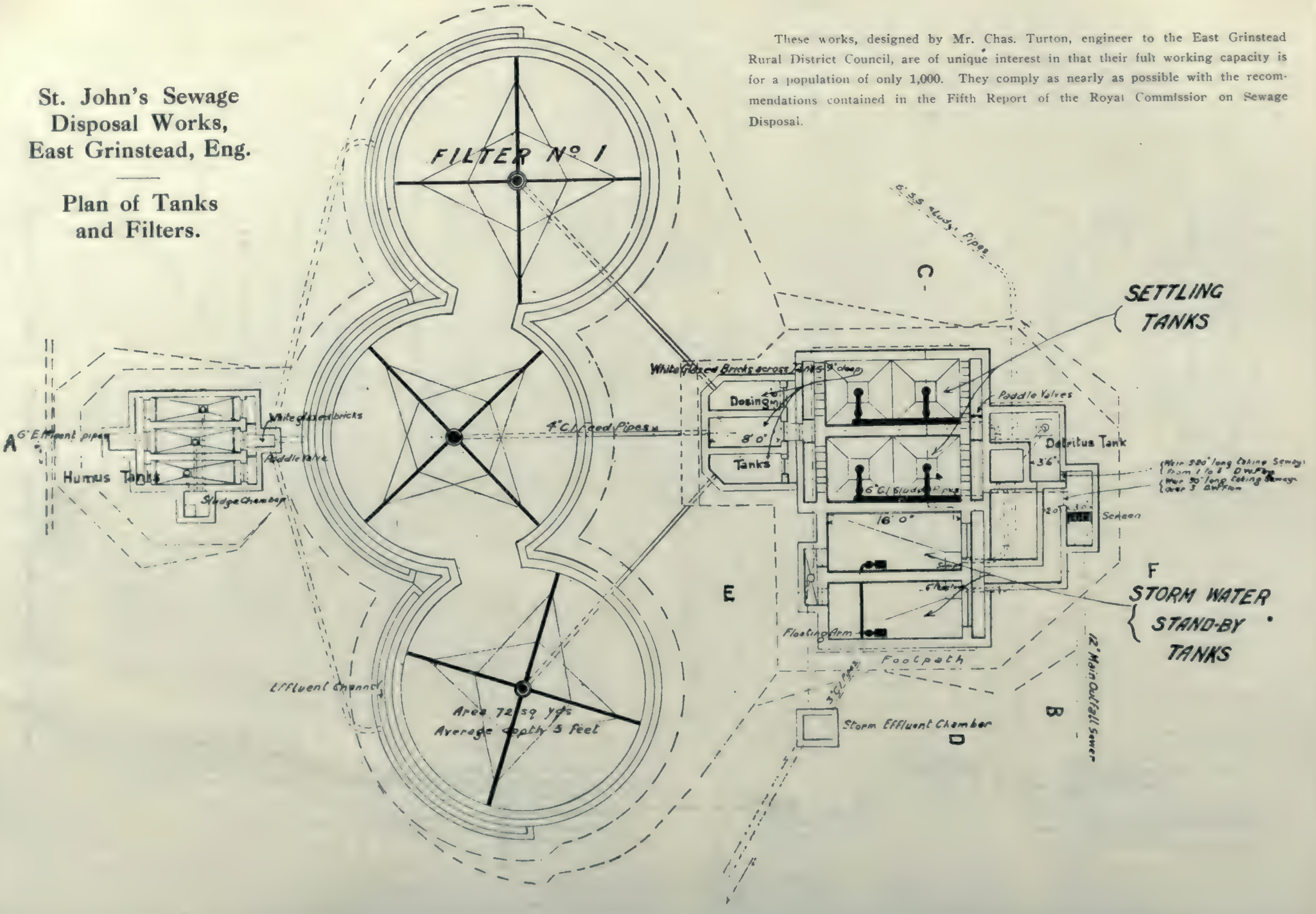
Plan of Sludge Beds.

St. John's Sewage Disposal Works, East Grinstead, Eng.

St. John's Sewage Disposal Works, East Grinstead, Eng.

Plan of Tanks and Filters.

These works, designed by Mr. Chas. Turton, engineer to the East Grinstead Rural District Council, are of unique interest in that their full working capacity is for a population of only 1,000. They comply as nearly as possible with the recommendations contained in the Fifth Report of the Royal Commission on Sewage Disposal.



Guano Company, for example, who are at work at Kingston-on-Thames—could be given.

Refuse Destruction

The expression "refuse destruction" must be taken in its widest sense, and not limited in its application to the process of incineration in specially constructed furnaces. There are—as residents of numberless rural districts in all parts of the country know to their cost—other methods of incineration, and an excellent specimen of "how not to do it" may be seen in operation now at a certain straggling village in Middlesex. Here some thousands of tons of London "rough dust" are being shot on the land and burned, the stinking smoke being visible to both eye and nose for miles around. Possibly about one-tenth of the refuse will be wholly or partially consumed, and the remainder will be spread over the ground as a foundation for choice building sites. The village, by-the-bye, is one of those miserable little "urban" districts which were created by the Act already referred to. There is not a street in the district, and its total population is only about 700. It forms a good dumping ground for London's waste material, as its staff are too busy diagnosing sore throat as diphtheria and gravel rash as measles to pay much attention to the health of the district.

Scientific Incineration

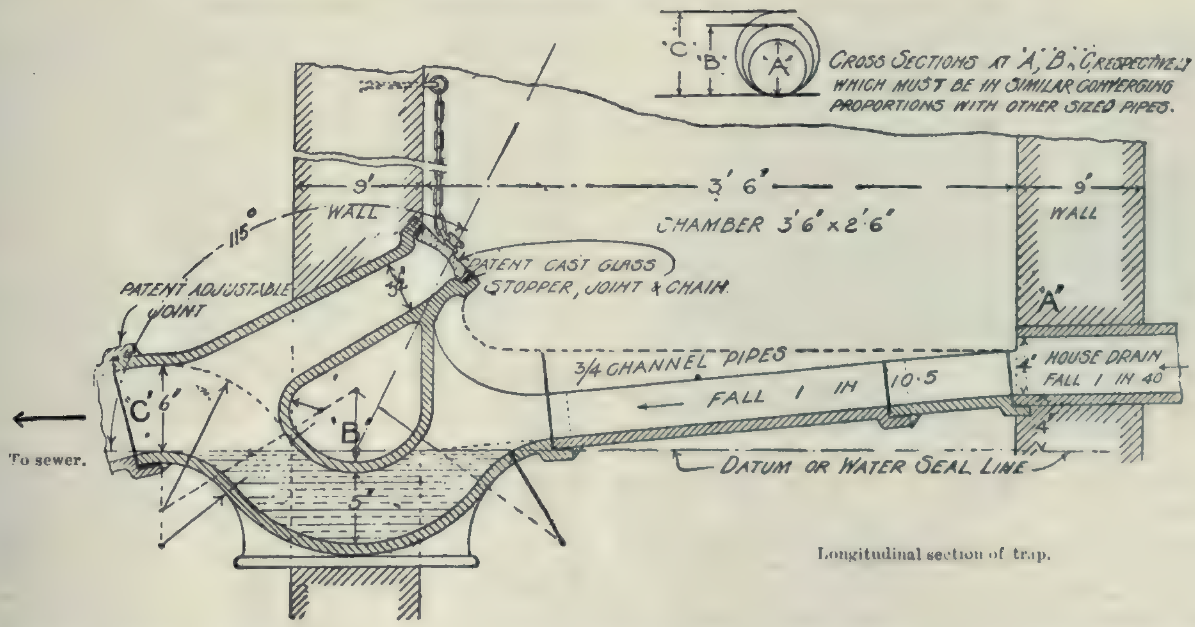
There has been no direct advance in the methods of legitimate refuse destruction during the past year, but the work has steadily progressed in the direction of increased furnace efficiency (tending towards economy of maintenance and better combustion), elimination of smoke and dust, more sanitary handling of the refuse and fuller utilization of the by-products. The arguments regarding the relative merits and demerits of front, top and back feed respectively still go on. Much nonsense was talked years ago as to the profits to be derived from the scientific burning of refuse. Although much has been done in the way of obtaining power for pumping, lighting and other purposes these profits have yet to be realized. The most that can be expected is a reduction in the cost of disposal, and this coupled with the mere fact of disposal itself, in a sanitary manner, is a great forward step.

Other Methods

The spreading of house refuse to a depth of 5 feet on the land of a sewage farm, and then running the sewage upon it for purification does not appeal to the imagination, although the system has apparently worked well at Leek, England, where the land available for irrigation was quite unsuitable for the purpose, owing to its stiff nature. The addition of the refuse to sewage sludge, the mixture being used as manure, is an undesirable form of disposal that has not only been advocated but actually put into practice, with results of a somewhat fluctuating nature. Apart from proper incineration, the direct conversion of the refuse into manure appears to be the best system extant. At Southwark, London, the "Patent Lightning Crusher" system has been in use for years, with excellent results, and many of the largest towns have now adopted it. The process is simplicity itself, and is absolutely free from nuisance, while farmers are ready purchasers of the manure.

Security of Tenure

For many years now English municipal engineers have been endeavouring to obtain superannuation and security of tenure. The sanitary inspector is the only individual who has anything of the kind, and his benefits are limited to security of a sort. His appointment is subject under certain conditions to the sanction of the Local Government Board, and his dismissal follows the same course. Thus, if his council decide to dispense with his services, he has at least the right of



Longitudinal section of trap.

Suggested "Regulation" Trap. This "Regulation" sewer-gas intercepting tank has been designed by Mr. Arthur Palmer, Deputy Borough Surveyor of Greenwich, Eng. The principal advantages he claims for it are (1) an easy bend direct from a sharp fall in the channel pipes giving soil greater impetus on entry to trap to reach sewer side direct; (2) no stoppage of trap possible, since its shape increases in diameter and area from house drain side to sewer side; (3) easy access from mouth of trap for clearing purposes; (4) cast-glass stopper chained so that if it be blown out by any sewer-gas pressure, it cannot fall into mouth of trap, and even if stoppage should exist and the chamber become filled, the stopper could be smashed from above the manhole; (5) a patent adjustable joint at C.

appeal to the Board, although the value of this is apt to be overrated. The life of a man whose retention in office was forced upon a council would scarcely be a bed of roses! Still, there is something in it, and there might be much more if the Board would exercise their full powers and would regard the inspector as their own servant.

The demand for security of tenure is a demand for the barest justice. No public officer should hold his appointment subject to the whim and caprice of a local body, the members of which only too often have a personal axe to grind. The resolution passed recently by the Wallasey Town Council: "That in future, if any official makes any application for increase in salary, contrary to Standing Order No. 54, and without his application being accompanied by his resignation, as provided for by previous resolution of this committee, such official be given notice to terminate his engagement," affords a glaring instance of the insecurity of an official's tenure. The Local Government Board have been appealed to on the matter and their views are as follow: "The Board are aware of no sufficient reason why any officer who thinks himself entitled to an increase of salary might not make application to the Council on the subject. It would rest entirely with the District Council to decide whether or not they would entertain the application, but the Board consider the Council could not legally enforce a regulation that before asking such application the officer should place his resignation in their hands when he holds a permanent appointment or an appointment for a fixed period." The unfortunate thing is that the vast majority of officers do not hold a permanent appointment or an appointment for a fixed period. They are many of them subject to the shortest notice, and in numerous districts appointments terminate each and every year and re-appointment has to be made annually.

During the past year nothing worthy of record has been done by municipal engineers towards obtaining either superannuation or security of tenure. The matter has practically been left to the National Association of Local Government Officers, with whom the two municipal engineering institutions are affiliated, and there it rests. A Bill is to be presented to Parliament some day, and it will meet, it is pretty clear, the fate of other measures of a similar tendency. Municipal engineering officials are sunk in a hopeless apathy, from which it is impossible to rouse them. They badly want superannuation—the cry is raised at meeting after meeting—and they absolutely refuse to raise a finger to help themselves. Still more do they want security of tenure—cases of flagrant injustice are constantly being discussed on the platform and in the press—and each and every man sits supine, awaiting his turn with the fatalism of a Chinese coolie. There is only one thing that will arouse them and that is to compare their professional societies with trade unions, arguing that only by strong combination (such as prevails in the trade unions), by agitation (such as is carried on by the trade unions), by something akin to equality in membership (such as obtains in the trade unions), will their grievances receive redress. Such wholesome advice will lash them into fury, because—it would be laughable were it not so tragic—their dignity has been touched. The child who stretches out his arms to grasp the moon has as much chance of getting it as has the municipal engineer of being granted either superannuation or security of tenure.

The Engineering Activities of the Department of Marine and Fisheries

By Lieut.-Col. Wm. P. Anderson, C.M.G., M.Inst. C.E., Chief Engineer

THE Chief Engineer's Branch of the Department of Marine and Fisheries is charged with the expenditure of the annual vote of the Government for the construction of aids to navigation, and finds that, in common with all other branches of the Government service, the duties are increasing rapidly with the growth of the country. Of late years the tendency has been, not so much to increase the number of aids to navigation, as to improve the efficiency of those already established, and especially to strengthen the lights and fog signals to meet the increased demands caused by the growth in tonnage and speed of modern steamers. Lights are now required to be picked up at greater distances than previously, and greater range of audibility is also asked for in fog alarms. A great many of the old wooden lighthouse buildings are being replaced by structures of reinforced concrete and of steel.

The fact that lighthouses are usually located on the most prominent headlands, and consequently on the points least accessible from the land side, presents many interesting and difficult engineering conditions, and in many cases, especially in British Columbia, the physical obstacles to be overcome are very great. At Langara, on the northwest extreme of the Queen Charlotte islands, the clearing of the site, the preparation of a landing place in a somewhat sheltered cove, and the building of a corduroy road from the landing to the tower, cost far more than the actual construction of the buildings. At Cape St. James, at the south extreme of the same group, the lighthouse is perched on the summit of a rock that rises to a height of 200 feet out of the Pacific ocean, and an inclined tramway had to be built from a little cove at the base of the rock to the summit. This is operated by a donkey engine at the lighthouse, which, now that the work is finished, has been left for the handling of supplies.

The scenery at both extremities of the Queen Charlotte group is wild and grand, but the conditions are utterly desolate. The rocks at the foot of the cliffs are the abode of countless sea lions, and the crannies and summits provide nesting places for innumerable sea birds.

At many light stations it has been necessary to build breakwaters, roads, and bridges, and to solve other engineering problems raised by the roughness or inaccessibility of the site. Fig. 1 shows a light suspension bridge built in St. Paul Island to allow the lightkeeper to reach the main islaid, as the sea is frequently too rough to admit of launching a boat. This bridge was designed and erected under the supervision of Mr. J. A. Leger, Resident Engineer of the Department at Halifax. Its span is 190 feet. The towers, of structural steel, are 32 feet high. The main cables are of plough steel, ⅞-inch in diameter, carried over the tower on roller bearings and anchored to eye bolts fastened into the solid rock. The wooden floor is suspended on half-inch round steel rods clamped to the cables and stayed with half-inch wire cables, three on each side.

On the St. Lawrence River a complete system of range lights has been established and all lighthouses on this stretch, where the sites happen to come on the low bank, have been built on high piers designed to protect the towers from the great rise of water that occurs during the winter freshets, and especially when the ice is running. (See Fig. 2.) The foundations are made of ordinary concrete in mass. The modern range light buildings throughout the St. Lawrence ship channel are built entirely of concrete or steel. Some of the back towers are carried up in skeleton framework to a height of 100 feet above the ground.

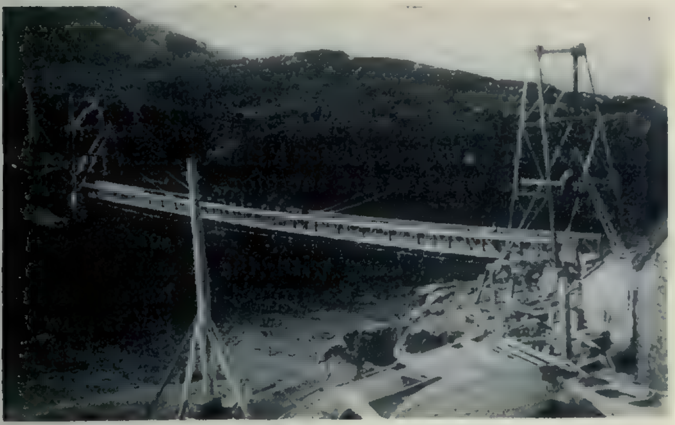


Fig. 1. Suspension bridge, St. Paul Island, illustrating difficulties of access to light stations.

In these towers the framing is made of angles, with the butts usually bolted to gussets, and in many cases the steelwork is galvanized after being shaped and fitted. It is our practice to make the framework heavier than the stresses demand, for the sake of securing rigidity against vibration of the illuminating apparatus. Usually these towers are surmounted by a wooden watchroom and lantern. It is our experience that woodwork removed so far from the dampness of the ground is practically as durable as the steel.

During the past season a new channel for shallow draft vessels has been completed from Repentigny to Lavaltrie. The axes of the tangents of this channel are marked by range lights, one of which is illustrated in Fig. 3, showing a skeleton steel frame carrying a day beacon and surmounted by a locomotive headlight lantern. These ranges are erected cheaply and prove very efficient. They are adapted for removal every winter, as the ice run during the spring freshet passes several feet over the piers.

All reinforced concrete towers are surrounded by buttresses to reduce vibration. It is found necessary to make the columns much stronger than theoretical requirements demand, for the purpose of securing steadiness in high winds.

Such concrete buildings are usually founded on solid rock, the vertical rods used for reinforcement being anchored into the rock. The rods reinforcing the buttresses are carried through the towers to make a solid bond from side to side through the floors. In some cases flying buttresses (Fig. 4) are used, the effect of them being light and artistic. Experiments are being made with a view to securing a dense and white surface on the exterior of these concrete towers, but no thoroughly satisfactory waterproofing has yet been found.

Lenses for illuminating apparatus have to be procured from England or France, but the metal lanterns, pedestals, revolving gear, lamps and other equipment for anadian lighthouses are being built more and more in Canada, and some very compact arrangements of clock-work and revolving gear have been installed lately. Some parts are secured from private makers by contract, while the remainder are built at the Department's Lighthouse Depot at Prescott, where every complete installation is assembled and tested before being sent to its station. All important apparatus are now illuminated by means of petroleum vapour burned under incandescent mantles.

The use of unwatched lights is increasing, especially in British Columbia waters, where it is difficult to secure keepers. These unwatched lights consist of lens lanterns supported over gas receptacles. In some of the lights, calcium carbide is used, the acetylene being generated automatically in small quantities as required for service. At other stations, a compressed oil gas or acetylene gas dissolved in acetone is utilized. Most of these beacon lights will burn for from six months to a year without attention, and have the additional advantage that they can be placed in position at short notice. It is probable that this system of lighting will be utilized for Hudson Bay and Strait in the near future. The use of acetylene dissolved in acetone on the Aga system seems at the moment to be giving the greatest promise of success, principally because it is not affected by extreme temperature conditions.

The Department has adopted the diaphone, of which the patents are controlled by the Canadian Fog Signal Company, of Toronto, as its standard fog alarm. Preference has been given to this instrument because its sound is the most penetrating yet devised and also because it is less apt to get out of order than the siren. In the diaphone, a loose piston moves backwards and forwards, air under compression escaping through slits in the piston and its jacket from a receptacle behind. The air is brought up to 25 or 30 lbs. per square inch—found to be the most economical pressure—by standard compressors, usually operated by internal combustion engines, though occasionally steam or electricity is used for the motor power. The compressed air is delivered to the diaphone from large reservoirs, so as to minimize the drop in pressure.

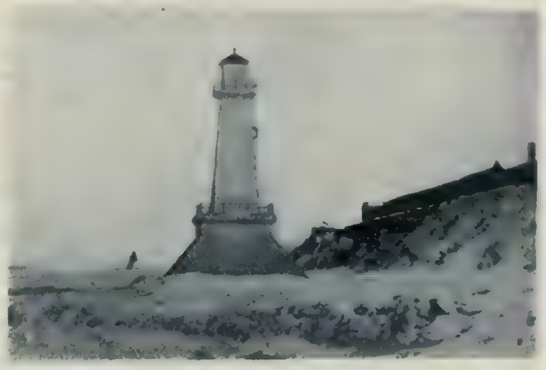


Fig. 2. Reinforced concrete lighthouse, Montreal harbor, built on mass concrete pier, designed to resist heavy ice shoves. Erected under winter conditions. In spring the water rises to top of slope on pier.

A small electric installation established recently in the beacon house at the extreme end of the breakwater in Port Stanley has given great satisfaction in consequence of its compactness and ease of operation. The motor is controlled by a switch distant one-half mile from motor. The current is three-phase, 25-cycle, 220 volts and actuates a combined motor and compressor manufactured by the National Brake Company, Milwaukee, which delivers 11 cu. ft. of free air per minute. The air is stored at 30 lbs. pressure and is supplied automatically at stated intervals, to a 1-in. diaphone instrument which absorbs 1 cu. ft. of free air per second of blast. Since the plant was put in operation last autumn it has run practically without attention, and without any opening up of the building on the breakwater.

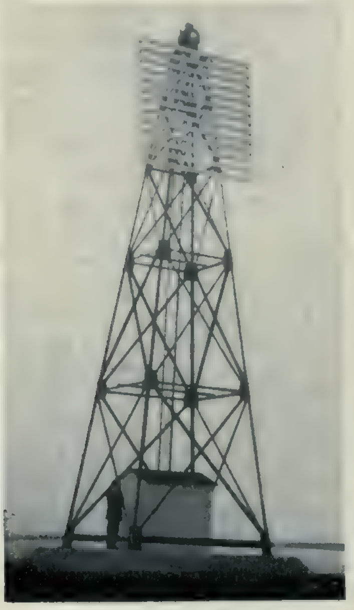


Fig. 3. Skeleton steel tower in Repentigny channel, designed for removal in winter to avoid ice shoves.

A number of submarine bells will be esablished during the coming season. In past years, experimental stations were established at which submarine bells, connected electrically and operated by dynamos on shore, were tested out, but it was found that this arrangement was not reliable and that the work of repairing breaks was difficult and tedious. The plan has now been adopted of attaching the submarine bells to buoys and operating them mechanically by power derived by the motion of the buoy on the waves. This system is much simpler and much less liable to get out of order than the electrically-connected bells. The advantage of the submarine bell signal is that water being of constant density the range of audibility through that medium remains constant and there are no aberrations of sound such as are always experienced with fog signals transmitted through the air.

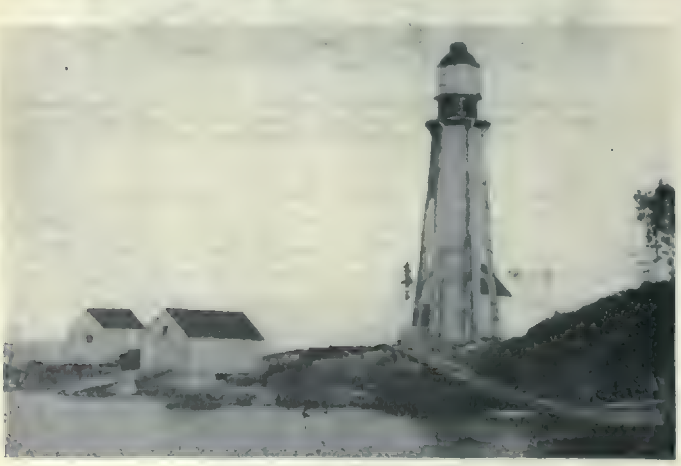


Fig. 4. Michipicoten east end lighthouse, showing construction in reinforced concrete, with flying buttresses.

The Department is now occupied in establishing depots for buoy work or for lighthouse service in different centres of the country. A new depot (described in detail by the author in the 1913 Annual Number of the Contract Record) has recently been established near Prince Rupert, B.C., and another, for buoy service only, at Amherstburg, Ont. The Prescott, Ont., depot, which is the principal depository of lighthouse supplies, has been greatly enlarged and improved. New sites have lately been secured at St. John, N.B., and Victoria, B.C., and work on the building of wharves at these depots is in progress. At St. John, the wharves are required to be extremely high to allow of the flotation of vessels of twenty feet draft at extreme low water, as well as to provide for a rise of tide of twenty-six feet. The wharves are therefore over fifty feet in height. These wharves are being constructed of concrete in mass with earth filling. At Victoria, where there is no ice to contend with, the wharf will probably be of piles creosoted to protect them from teredo.

The Department of Marine and Fisheries is now co-operating very cordially with the Department of Public Works in the improvement of channels. Whenever the Department of Public Works does any dredging it furnishes the Marine Department with full details of the work accomplished and the Marine Department provides the necessary aids to navigation to mark the improved waterway. A large number of buoys, day beacons and range lights, usually of small value, but aggregating a considerable expenditure, have been established during the past year and a continuation of this work is contemplated during the present season.

An interesting duty of the Chief Engineer's branch is the control of ice-breaking contracts for the purpose of prolonging the season of navigation, especially at the head of the Great Lakes. Last autumn very little work was required in consequence of the open season, but in the autumn of 1912 and spring of 1913 extensive operations were carried on at Fort William and Port Arthur, and in the Sault river, enabling vessels to transport wheat from the terminal elevators up to an unusually late date.

A 78-suite apartment house of brick and tile construction is to be erected at Winnipeg this season by Messrs. Oddson & Company, at a cost of nearly $250,000. The new building will be replete with all modern improvements in the way of fire escapes, telephone system, vacuum system, and so on. The foundation work is now in progress.

A rather unique problem confronting the contractor having under way the construction of houses to quarter the men engaged in building the gigantic tunnel through the Selkirk range of the Rocky Mountains at Glacier, B.C., was the drifting snow which made it almost impossible to proceed with the work in a satisfactory manner. As a consequence the idea was conceived of building a village on stilts. The floors of the houses are to be 8 ft. above the ground and the streets will have no sidewalks but there will be a walk in the centre also 8 feet above the ground level and connected with the doors of the several houses by little bridges.

Foundations of the Dam across the North Saskatchewan River at Lacolle Falls

By F. A. Creighton, Consulting Engineer, Winnipeg

THE series of rapids known as LaColle Falls is situated about twenty-five miles below Prince Albert on the North Saskatchewan River, continuing from this point to the junction with the South Branch, about twelve miles lower down stream. The total fall in this distance is about 95 feet.

A hydro-electric development, utilizing the upper portion of this fall, is being undertaken by the city of Prince Albert for the purpose of supplying power for general purposes. The development consists essentially of the following items: dam, navigation lock, intake works, head canal, power house, and tail race.

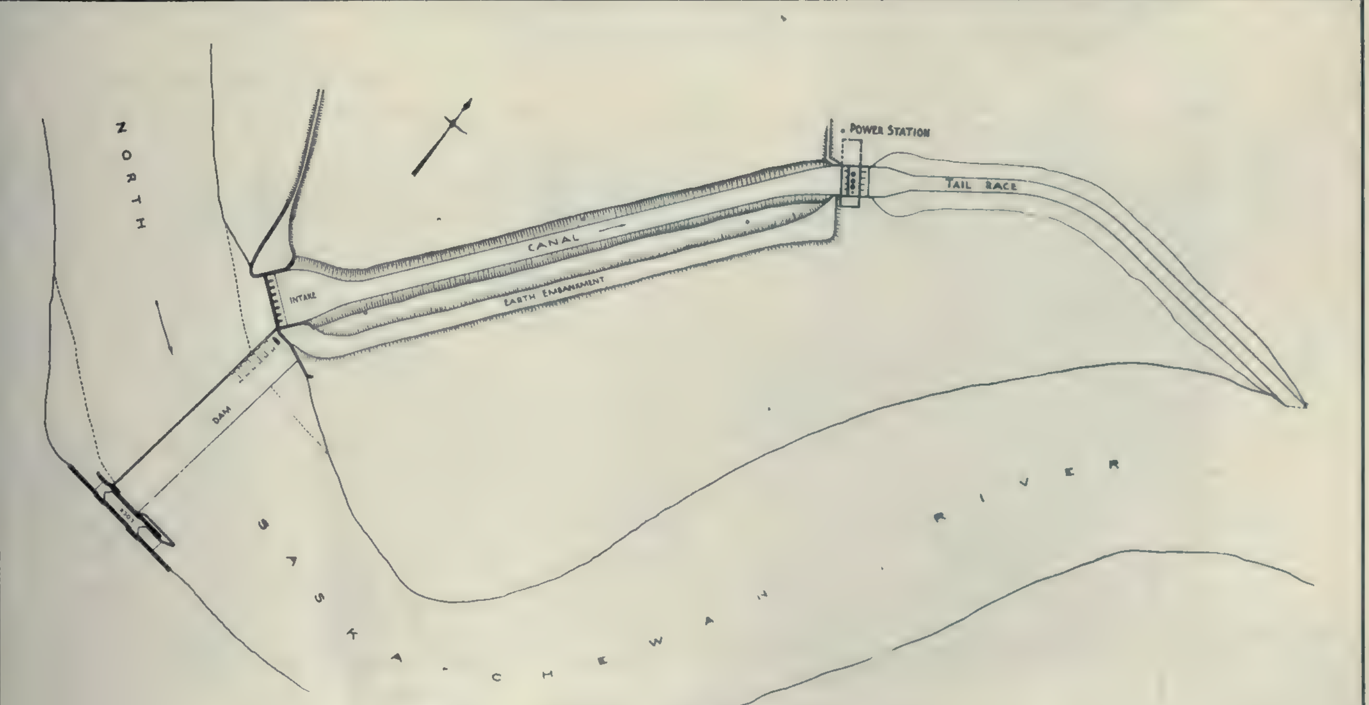
The portion of the river affected by the works is roughly five miles in length. The width varies from 500 to 1,000 feet and the fall is as great as ten feet in a mile. The general direction of flow is from west to east. The dam creates a head of from twenty to twenty-two feet and the river falls between the dam and the outlet of the tail race from six to eight feet, so that the developed head is normally twenty-eight feet.

The navigation lock is situated at the south end of the dam and is built as a component part of the structure. The intake works are at the north end of the dam, and are also built as a continuation of the dam structure. The head canal is cut in a northeasterly direction from the intake to the power house, a distance of about 2,000 feet. The depth of cutting varies from sixteen to twenty-five feet. The power house is situated on the flat 2,000 feet from the dam, its location being determined by the most northerly point at which a suitable foundation could be obtained. The tail race is 1,800 feet long, extending from the power house to a point as far down the river as it was economically feasible to go. The head canal, power house and tail race are built to develop 6,000 h.p. and are located for enlargement to 12,000 h.p. at a later date. The remainder of the work is built to what is intended to be its ultimate capacity.

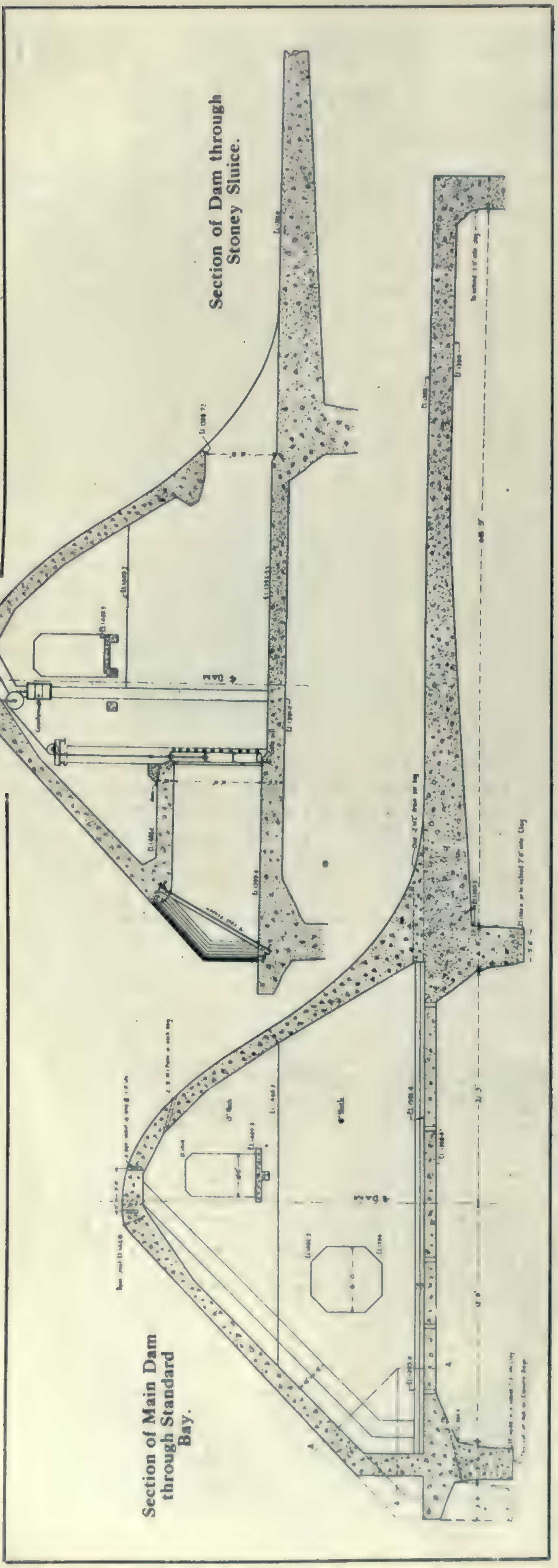
The distance covered by the work, from the extreme west end of the navigation lock to the east end of the tail race, is somewhat less than a mile. The general layout of the plant is shown in Fig. 1.

The Saskatchewan River at the point where the dam is being built is about 750 feet in width and the greatest depth at normal flow is about eleven feet. The normal summer flow of the river appears to vary between 20,000 and 40,000 cu. ft. per second, while a flow of 162,000 cu. ft. per second was observed in the year 1899. The surface elevation at normal water is 1400.00, referred to the datum used by the special survey being carried on by the Department of Public Works, this datum having been adopted and used throughout the work.

The governing elevations in connection with the work are as follows: spillway, 1420.00; flashboards, 1422.00; excavation for dam, 1389.00; bottom of cutoff walls, 1384.00; floor of dam and tumbling hearth, 1392.00; upper mitre sill of lock, 1416.00; lower mitre sill of lock, 1392.00; floor of intake works, 1406.00, bottom of canal at power house, 1405.00, and bottom of tail race at power house, 1385.00.



Plan of hydro-electric development at Lacolle Falls, North Saskatchewan River.



Section of Dam through Stoney Sluice.

Section of Main Dam through Standard Bay.

The bottom of the river valley in the vicinity of the work has evidently been subjected to numerous local influences which have scoured the original formation and rendered the subsequent deposit most irregular and uncertain, and in nowise to be relied upon without a most thorough investigation covering all the ground which can in any way influence the stability of the work.

The selection of the actual site for the LaColle Falls dam was a long and tedious process and was only accomplished after six months of continuous exploration, extending for about three miles along the bed of the river.

The outfit used for this work consisted of: small single cylinder hoisting engine; duplex horizontal pump 2½-in. discharge; 15 h.p. boiler; hammer weighing 150 lbs.; sheaves, pulley and hoisting rope 1¼-in.; wrought iron pipe (heavy) 3-in., 2-in., 1-in.; and hose, tools, etc. The work was begun with one of these outfits, but it was afterwards found necessary to purchase another. The cost of an outfit ready to go to work was about $700.

The method employed was to drive the 3-in. casing pipe into the gravel overburden by means of the hammer, which was raised by the niggerhead on the engine and dropped by gravity. The gravel inside the casing was washed out by means of the pump and the driving continued until clay was reached. The cores were taken through the clay by means of a 2-in. pipe driven inside the 3-in. casing. Only about 4-in. to 12-in. core was taken when the core pipe was removed and the core drawn out. It was always the endeavor of the operators to have the casing sealed in the clay to prevent the infiltration of the river water and so determine whether the clay stratum and contained sand pockets were absolutely dry or not. Holes were driven in this manner to a depth of 70 feet.

The results obtained from this method of examining earth foundations would appear to indicate that the test is a very severe one, and that any soil giving satisfactory results might be reasonably expected to improve on closer examination with pick and shovel.

No Solid Rock Was Encountered

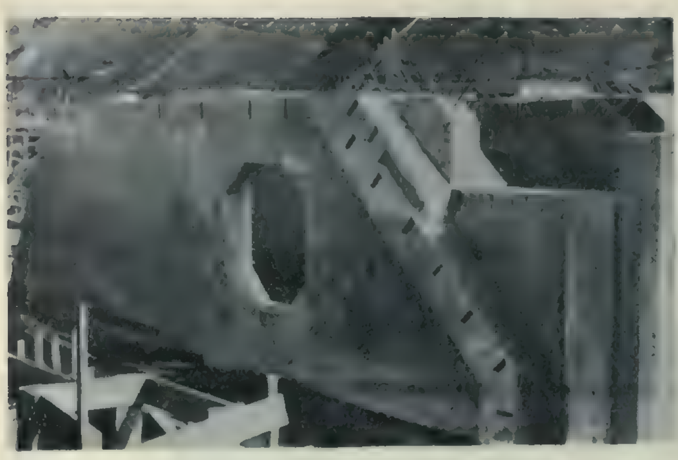
The underlying formation appears to consist of a very firm, hard and impervious clay carrying a certain amount of sand, with scattered particles of gravel. Boulders were rarely encountered in this clay. Sand pockets varying in size from a few cubic inches to a few cubic yards were common, but continuous strata of any material other than the clay were not, as far as it was possible to determine, encountered after the real clay was reached. The sand pockets encountered were invariably dry, showing that there could be no connection with the water of the river.

The boring operations, as above noted, covered a distance of about three miles along the bed of the river. At the first site selected as a possibility for the dam two borings were put down revealing a depth below water level of 70 feet of coarse gravel and sand, with hardly more than a trace of clay. As the borings were discontinued at this point it is not known at what depth a solid foundation might be found. A second possible site, situated about one-and-one-half miles below the first, was then prospected but the results obtained at this point were little better. A stratum of clay of a more or less impervious nature was found at a moderate depth, but the thickness was in places only ten feet and the sand and gravel under-

Coffer-dam, showing constructed portion of lock and dam.

Up-stream view, showing lower lift dam buttresses.

Lock and dam under construction. Looking up-stream.



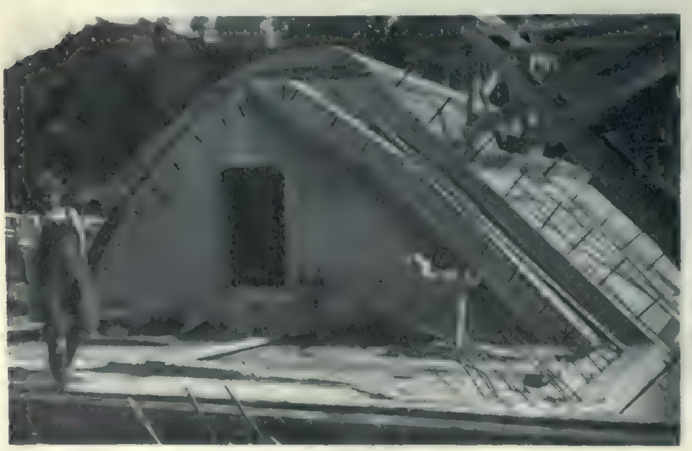
Hydro-electric development at La Colle Falls. Lower lift, buttress 19, from north side of coffer-dam.

lying it contained water under a pressure head of about five feet.

The results obtained at the third, fourth and fifth possible sites showed a gradual improvement, but nothing upon which it could be considered safe to construct a dam under the required head without a prohibitive expenditure. The underlying clay was in no case found extending across the river valley at an elevation that could be reached at a cost at all commensurate with the earning possibilities of the scheme. At the sixth possibility, which is the site on which the dam is now being built, the surface of the clay was found to reach within a few feet of the bed of the river and was overlaid with only a few feet of boulders and gravel. This condition prevailed, however, only at the actual site chosen for the dam and for a very short distance up and down stream, from which points it fell away rapidly until at points 500 feet distant the covering would reach a depth of fifteen to twenty feet.

Having discovered a site upon which it appeared to be practicable to construct the dam, borings were put down in the following order for the purpose of proving beyond reasonable doubt that the deposit of impervious material was continuous: 1, centre of river at dam site; 2, centre of river 500 feet above site; 3, centre of river 500 feet below site; 4 and 5, each side of river opposite 3; 6 and 7, each side of river opposite 1; 8 and 9, each side of river opposite 2. These holes were all sunk to a depth approximating sixty feet, and the results shown were considered satisfactory.

Intermediate holes were then sunk at closer intervals to depths ranging from twenty-five to forty feet. On the site selected for the dam the spacing of the holes was less than fifty feet, and where an appreciable pocket of sand was discovered extra holes were put down to determine its extent. The real nature of these sand pockets, however, was not fully understood until after some of them were actually exposed in the excavation for the foundation. It was then found that they were of small extent and that there would be no difficulty in dealing with them so that the safety of the work would not be affected.



Hydro-electric development at La Colle Falls. End section, showing upper lift of buttress of dam.

The dam is of hollow reinforced concrete construction of the Ambursen type. A typical cross section is shown in Fig. 2. There are three cut-off walls, each thirty inches thick. One is located at the upper face, another at the junction of the dam proper and the hearth, and the third at the lower end of the hearth. These walls extend noramlly five feet into the clay, but in the even of a pocket of sand being disclosed, the walls were carried five feet beyond the limit of the sand.

The question of driving sheet piling into the bottom of the trench for the upstream cut-off wall as an additional precaution, was considered at some length, but it was decided that this was unnecessary. Ten weep holes per bay were left in the floor of the dam for the purpose of relieving any upward pressure which might develop. The floor of the dam is level throughout its length. The spillway section is 755 feet long, which includes the entire width of the river at this point. The navigation lock which is 150 ft. x 40 ft., inside measurement, is built as a part of the dam structure, the north lock wall forming the south end wall of the dam. The upper cut-off wall of the dam extends under the lock wall and across the lock under the lift wall and into the bank on the south side, the idea being to form a continuous cut-off and preclude any possibility of leakage, as it was fully realized that any leakage which was allowed to attain a flow sufficient to cause abrasion would soon develop considerable dimensions, and the resulting damage would be very extensive.

Hydro-electric development at Lacolle Falls. Lock from lower end.

At the north end the intake works are tied into the dam. In this case the cut-off walls will be continued along the retaining wall on the lower side of the canal, and if it should appear to be necessary when the bottom is exposed, sheet piling will be driven as an additional precaution against scouring. When the work closed down in the autumn of 1913 the lock was practically completed and the spillway section was

Hydro-electric development at Lacolle Falls. Upstream view of dam under construction. The suspension footbridge, which can just be seen in the illustration, was a feature of the constructional operations worthy of note.

built for a distance of 300 feet from the lock, or about three-fifths of the width of the river. About four-fifths of the floor of the intake was also finished. When the work is resumed the remainder of the dam and intake will probably be built in one cofferdam, and the flow of the river will be taken care of through the opening left in the south part of the dam.

This work is interesting from the fact that it is a comparatively large and expensive structure built on a foundation which does not pretend to have the stability of solid rock, while the quantity of water which will have to be handled during extreme floods is enormous.

The conditions are somewhat similar to those obtaining at the C. P. R. irrigation dam across the Bow River at Bassano. The dams are of approximately the same size and design. While the foundations at La-Colle Falls are somewhat more stable than those at Bassano, the quantity of water to be handled at the former is more than double that at the latter. The best engineering talent in the country has been brought to bear on both pieces of work, and the results when put under actual operating conditions, will doubtless be watched with great interest.

Portland cement works with an annual capacity of 120,000 tons have been built at a cost of $700,000 at Aberthaw, South Wales, according to a recent consular report. The works have tidewater communications and adjacent thereto are quarries of argillaceous clay and limestone, said to be of the same quality as the deposits in the Lehigh Valley, Pennsylvania.

The total quantity of concrete laid in the Panama Canal and its auxiliary works to March 1 of this year is more than 5,000,000 cu. yds. This includes the work on fortifications, the Gatun Locks, the Pontoon barge piers at Baraiso, the Miraflores Locks and the Pedro Miguel Lock and dam.

Hydro-electric development at Lacolle Falls. Lower entrance of lock under construction, showing portion of dam, (on the right).

Lynhurst bridge, St. Thomas, Ont. (116 ft. span). The longest Canadian earth-filled arch.

Recent Developments in Concrete Arch Bridges in Canada

By **Frank Barber**[*]

EARTH-filled concrete arch bridges are being superseded by open spandrels to a considerable extent and the latter are being used on shorter spans than ever before. On the very long spans which are always associated with considerable rise from skewback to crown, economy makes open spandrels almost a necessity because of the great weight of the filling which would be required for the older style. All, or nearly all, of the concrete arches of over 175 ft. span have spandrel posts resting on the arch rings or ribs and supporting the floor system. In the last two or three years the advantages of the open spandrel have been so well appreciated by designers that it has been used on many shorter spans from 40 ft. to 100 ft.

The first Canadian arch bridge of this type was completed in 1910, and five have been built since, as given in the list.

In earth or sand covered arches the horizontal pressure of the fill against the arch ring, which may be as much as one-third of the vertical pressure, should certainly be allowed for in designing. In fitting the neutral axis of the arch to the line of resultant pressure, it is quite easy to take account of both the horizontal and the vertical thrusts of the imposed loads, but in analyzing the arch to determine the necessary and sufficient depths of ring from crown to springing, horizontal loads greatly complicate the problem. Besides this, the assumption as to the thrusts due to the filling are uncertain chiefly because the weight of earth varies with the time of year and the amount of moisture contained. But in the spandrel post arch the imposed loads on the ribs are all vertical and are definitely known. The solid arch ring of the filled arch generally becomes split up into two or more ribs in the open spandrel type. The greater depth of rib resulting from this is better to resist live loads but for temperature changes is not so well. At all events the ribbed arch allows the designer to pick out the economical form of section for the ribs, both as to depth and width, where in the older type he has no choice as to width of ring as it must be equal to the width of roadway. In the ribbed arch the floor is cantilevered out at the sides over the supporting posts, allowing narrow abutments and piers, the economy of which over the filled arch type is very evident.

Hinged or pivoted concrete or masonry arches are fairly common in Europe but not in America, and no example of them exists in Canada.

Doubtless existing Canadian concrete bridges will be greatly exceeded in size and importance in time to come. In order to show the development of the art at this period and for comparison with the list of open spandrel arches the list of filled arches has been prepared.

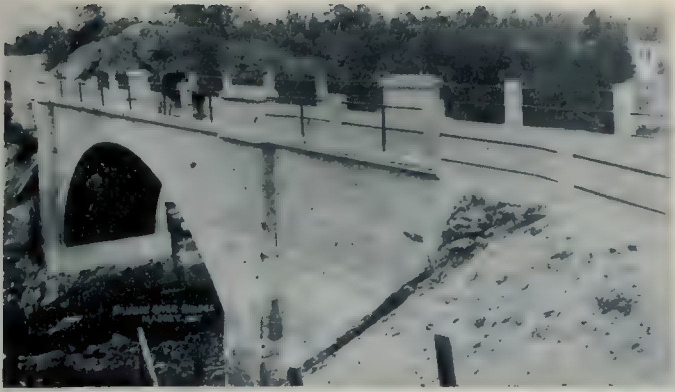
A variation of the common type of filled arch is what may be called the "horseshoe" arch. This has no spandrel walls and the concrete superstructure consists of the arch ring alone, which is made wide at the base and narrow at the crown to fit the fill. Consider, for instance, such an arch supporting a fill 20 feet wide on top with side slopes one and one-half horizontal to one vertical, the roadway being 12 feet from the natural ground at the water's edge. Here the arch ring would be 56 feet wide (measured parallel to the direction of the stream) at the skewbacks and about 25 feet wide at the crown, supporting only about 1 foot of fill over the crown.

The horseshoe arch is economical where the rise is considerable compared to the span. In one case, that of a full-centered arch, where the quantities were computed for both styles, the horseshoe arch contained 20 per cent. less concrete than the common form with spandrel walls.

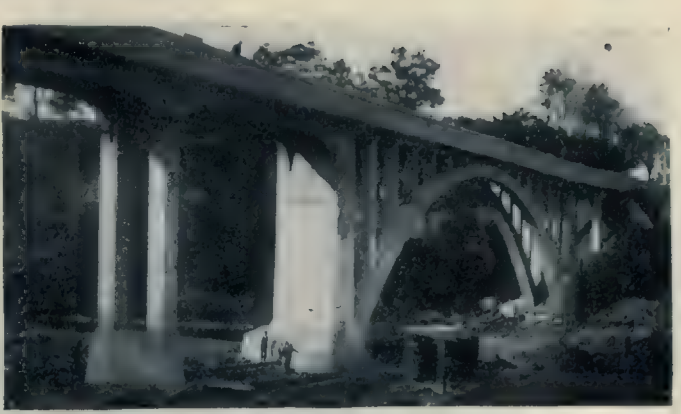
An advantage of the horseshoe arch which is worth noting is that it can be correctly analyzed when built on the skew. The analysis of the ordinary skew arch is beyond the skill of present-day mathematicians. This was made clear by the report of the Commission who

---

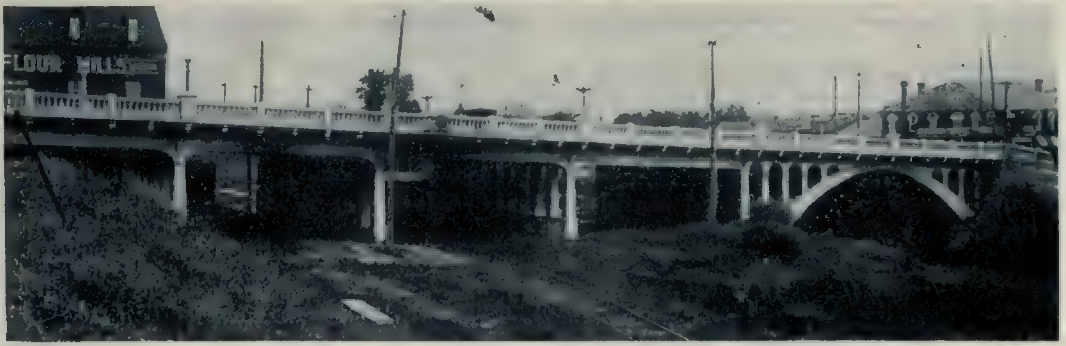
[*] Consulting Engineer, Toronto. Engineer to York County.



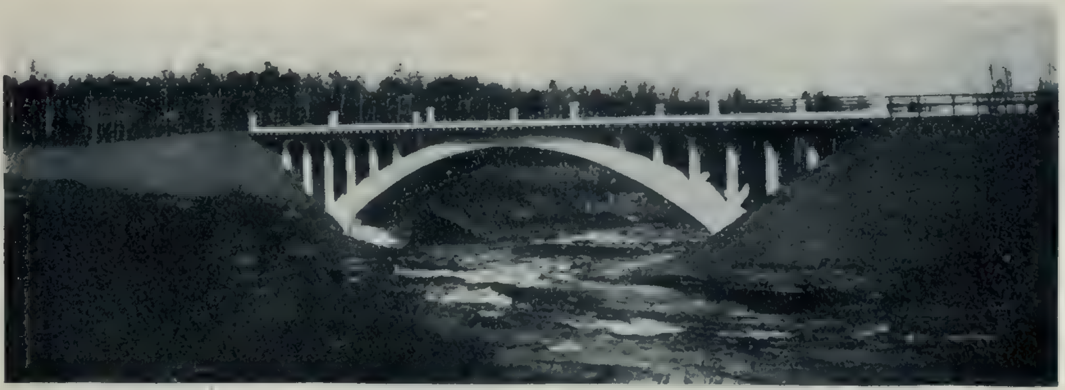
Massey bridge.



King George arch, Oakville, Ont.

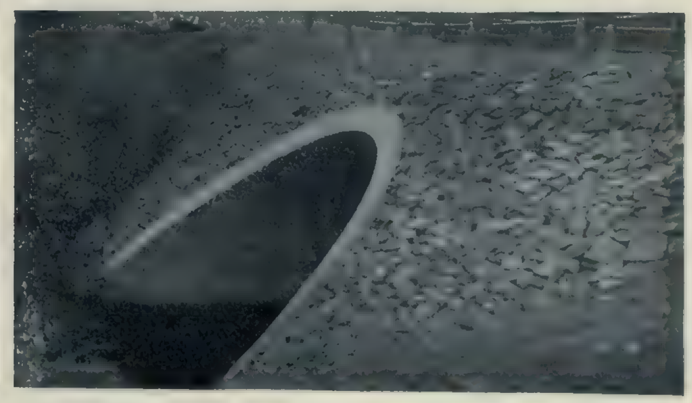


Victoria bridge, Brantford.



Open spandrel arch, with clear span of 130 feet, built at Port Arthur, Ont.

Wadsworth arch, west approach.



McConnel's bridge. "Horse-shoe" arch.

Concrete truss, Wellington County, Ont.

examined into the causes of the failure of a large skew arch in Australia. But a horseshoe arch built askew contains a right arch.

Horseshoe arches have been built in Canada for the Metropolitan Railway at Newmarket, near Penetang, for Tiny Township, and between York and Markham Townships for the County of York.

Birrel's bridge, York Mills.

Canadian Open Spandrel Arches

	Clear span of main arch	Number of spans	Engineer
King George Arch, Oakville, Halton County, 1913.	135 ft.	9 spans Length 476 ft.	Jas. Hutcheon, County Engineer. Frank Barber, Consulting Engr.
Port Arthur, 1913.	130 ft.	1 span	L. M. Jones.
Wadsworth Arch, Weston, 1910.	18 ft. 6 in.	1 span	Barber & Young.
Fergus Bridge, Wellington County, 1912	80 ft.	1 span	Bowman & Connor, Engineers.
Kleinburg Arch, 1913, York Highway Com.	65 ft.	1 span	E. A. James, Engineer to Comsn.; Frank Barber, Bridge Engineer.
Victoria Bridge, Brantford, 1911, Market Street South.	60 ft.	5 spans Length 250 ft. Width 64 ft.	T. Harry Jones.

There are now ten examples in Canada of concrete arches with suspended floors, generally called concrete trusses. In this form of bridge the top chords are arched and their ends are usually tied by steel rods concreted over forming the lower chords of the trusses. These lower chords thus resist the horizontal thrust of the arched upper chords, where in the ordinary form of arch bridge the natural earth between and below the foundations must resist the horizontal pressure which tends to push apart the skewbacks of the arch and the abutments. In the ordinary arch the earth thus takes the place of the lower chord of a truss.

Where diagonals are used in the web system as well as lower chords to take up the horizontal thrust such bridges are true truss bridges, and where only vertical web members are used, they may be called trusses without diagonals.

It may be of interest to mention that a number of

Highland Creek bridge, Kingston Road, York County.

Freeman's bridge, York County.

such "trusses without diagonals," so-called by their designers, have lately been built in steel, either with or without arched upper chords.

Where the upper chord of a concrete truss is in the shape of a parabola, as is usually the case, the vertical web members are tension chords, and the diagonals, if any are used, are only stressed for eccentric loads and are thus in the nature of counter-braces.

A concrete truss bridge should be built at about the same initial cost as a good steel bridge with a concrete floor.

If the concrete truss bridges here illustrated had all been built upon masonry abutments of heavy coursed rubble, as in the case of the Highland Creek bridge, probably a more pelasing appearance would have resulted by reason of the contrast between the smooth surfaced superstructure and the masonry abutments.

Canadian Earth-Filled Arches

	Clear span of main arch	Number of spans	Engineer
Lynhurst Bridge, near St. Thomas, Elgin County, 1909.	116 ft.	1 span	Jas. Bell.
Coaticook, Quebec, 1912.	100 ft.	1 span	
Bridgewater, Hastings County, 1913.	100 ft.	1 span	Lucius E. Allen.
Bancroft, Hastings County, 1913.	100 ft.	1 span	Lucius E. Allen.
Massey Bridge, Ontario Govt., 1906.	92 ft.	1 span	W. A. McLean, Prov. Engineer of Highways.
Queen's Bridge over Kettle Creek, Elgin County, 1908.	80 ft.	2 equal spans	Jas. Bell.
Spry's Bridge over Moira River, Hastings County, 1913.	80 ft.	1 span	Lucius E. Allen.
Peterborough Arch Bridge		3 spans	T. S. Hay.
Brewery Bridge over Kettle Creek, Elgin County, 1908.	75 ft.	1 span	Jas. Bell.
Orwell Bridge, Elgin County, 1908.	75 ft.	1 span	Jas. Bell.
Kirkham Bridge, Scarboro Tnp., 1910.	70 ft.	1 span	Frank Barber.

Concrete Truss Bridges or Arches with Suspended Floors

	Clear span	Engineer
Freeman's Bridge over Rouge River, York County, 1911.	91 ft.	Frank Barber
Middle Road Bridge, over Etobicoke River, Counties of York and Peel, 1909.	79 ft.	Barber & Young
Eckardt Bridge near Unionville, York Highway Commission, 1913.	70 ft.	E. A. James, Engineer to Comsn.; Frank Barber, Bridge Engineer.
Birrel's Bridge over River Don, York Township, 1913.	65 ft.	Frank Barber.
Simpson's Bridge, Amaranth Township, 1912.	60 ft.	Frank Barber.
Highland Creek Bridge, York County, 1912.	60 ft.	Frank Barber.
Bridge near Collingwood, Simcoe County, 1912.	55 ft.	R. H. Jupp, County Engineer; Frank Barber, Consulting Engineer.
Lower Haliburton Bridge, Mun. of Dysart, 1911.	55 ft.	Frank Barber.
Wellington County, 1913,	50 ft.	Bowman & Connor.
Sproul's Bridge, Amaranth Township, 1913.	50 ft.	Frank Barber.

The Steel Structure of the Dominion Bank Building, Toronto

THE new head office building of the Dominion Bank of Canada, which is situated on the south-west corner of King and Yonge streets, Toronto, occupies a rectangular lot of 168 feet frontage on Yonge street and 75 feet on King street, running through to Melinda street.

The building has a basement and sub-basement, and including the mezzanine floors above the second and the ninth floors there are fifteen tiers of horizontal steel supported by forty-nine main columns, and a number of columns running through only a portion of the height. The total height of the steel frame is about 200 feet, of which 28 feet is below the sidewalk level. The total weight of the structural steel is approximately 2,250 tons. The structural design is of the typical skeleton frame type, with all vertical and wind loads carried by the steel to the foundation on bed rock.

Solid rock was found at 28 to 30 feet below the sidewalk level. In some cases it was found necessary to cut into the rock to get sufficient depth to bed the column grillages. The grillages consist in general of two tiers of I-beams arranged to distribute the load uniformly over a circular concrete pier.

The greatest column load occurred on the two front columns which support the girders over the main entrance, amounting to 2,400,000 pounds. A section of this column and the arrangement of the grillage are shown in Fig. 1. Along the west well, the columns are too close to the lot line to use a circular grillage, so to avoid cantilever girder the grillages are made of a single tier of I-beams, surmounted by a cast iron base. The supporting pier is long and narrow, it being 3 ft. x 11 ft. for the heaviest wall columns on this side.

Owing to the necessity for large clear spaces in the ground floor and main banking floor some very heavy column loads are carried on girders. The heaviest of these girders has a maximum bending moment of 9,031,000 foot pounds on a span of 40 ft. c.t.c., and a maximum shear of 671,300 pounds. These were designed as twin girders with plate and angle diaphragms at the point of applied load. The material in these consisted of: 2 web plates, 72 x ⅝; 8 flange angles, 6 x 6 x ¾; 16 flange plates 14 x ¾, the flange plates being cut as the bending moment would permit. The weight of steel in a pair of these girders is 43,650 pounds. The girders were carried by columns of box section and the connection was made by letting the two web plates run past the faces of the column and rivetting them direct thereto. One connection required 128 ⅞-in. diameter rivets. As the space between the webs of the girders did not permit of the diaphragm rivets being driven from the inside, they were connected by ⅞-in. diameter turned bolts passed through the two webs and the diaphragm.

The typical floor, shown in Fig. 3, consists of ordinary framing of Bethlehem I-beams. All the col-

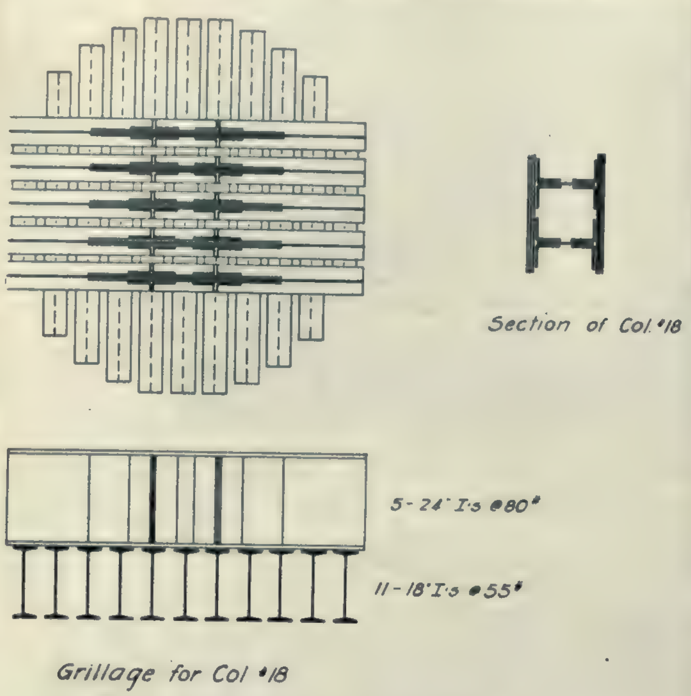


Fig. 1.—(Dominion Bank Building).

umns above the second floor are Bethlehem H-sections. In all connections of beams to columns, except the wall beams, header connections are used to give greater rigidity to the building and also to avoid projecting stiffener angles on the column flanges below the beams. No wind bracing was used above the second floor as it was considered that these stiff connections would give the necessary bracing.

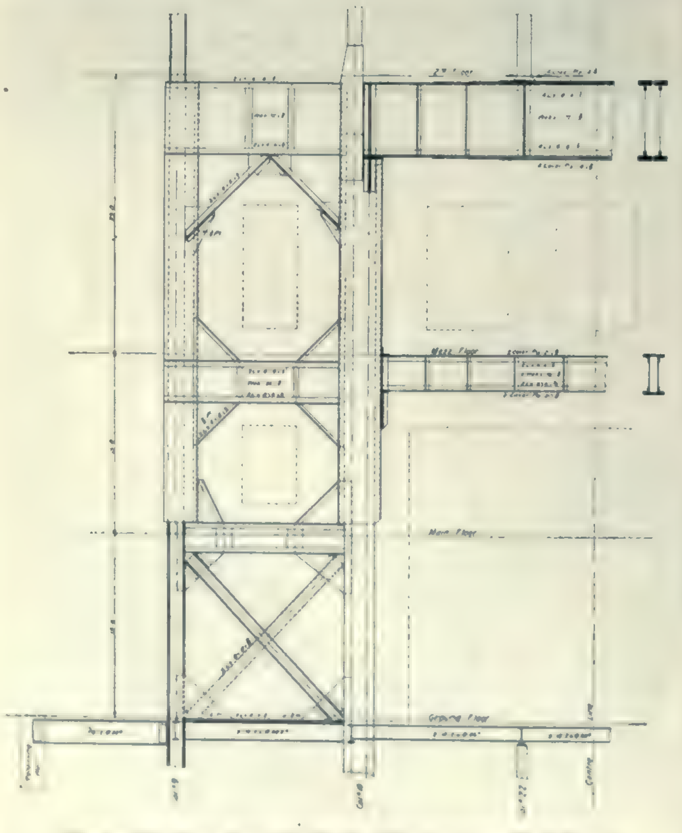


Fig. 4.—(Dominion Bank Building). Wind bracing. King Street.

The wind bracing in the King street front below the second floor is shown in Fig. 4. This shows only one-half the width of the building. In the Melinda street front the bracing consisted of horizontal plate girders at the floor levels connected to vertical girders on the column faces by deep plate knee brackets, stiffened with angles. The cut shown as Fig. 5 gives an idea of this arrangement. The end bays on the east and west faces of the building were also braced by knee brackets from the second floor to the basement.

The erection of steel was carried out by two steel guyed derricks of 15 tons capacity each, with 85-ft. masts and 75-ft. booms. Two floors were erected from one position of the derricks which were then raised by using the boom as a gin-pole to raise the mast and then raising the boom to its place by means of the mast.

The complete steel frame was erected in ten days less than three months, or at the rate of about 850 tons a month. The heaviest single piece of steel to be lifted was half the twin girder above noted, which weighed 11 tons. The heaviest column sections were nearly the same weight.

On the east side of the building under the curb it was necessary to put in a retaining wall, which, for a length of over fifty feet, has an unsupported height of twenty-eight feet. This was designed as a vertical slab supported at the sub-basement and the ground floor. It is of reinforced concrete, 26 in. thick, reinforced with vertical rods, 1 in. diameter at 4½ in. centres and with horizontal rods—to prevent shrinkage cracks—¾-in. diameter at 18-in centres. The retaining wall on the west side also acts as a bearing wall to support the four-storey brick building on the next lot.

The architects for the building are Messrs. Darling & Pearson, with Messrs. Harkness & Oxley, Toronto, as consulting engineers for the structural design. The general contractors are The Canadian Stewart Company, Limited, and the contractors for the steel work, Canadian Allis-Chalmers, Limited, Toronto. The steel was erected by The J. Hendricks Company, of New York.

Regina, Sask., is to have a new Customs House this season, the estimated cost being $200,000. It is stated that tenders will be invited at an early date.

The architects' competition in connection with the government buildings at Ottawa is closed. The judges have selected six designs and their final decision will be announced early in September. The cost of the work is estimated at five million dollars.

Classified estimates for bridge superstructures have been satisfactorily used for the payment of contractors by Mr. R. S. Uniacke, bridge engineer of the N. T. R., Canada. For a total unit price of $4.23 per 100 lb. of finished superstructure the six estimates allowed are: Delivery of steel, $1.95; fabrication, $1; delivery at site, 20 cents; assembling, 80 cents; riveting 15 cents, and painting and full completion, 13 cents. The system of reports on record makes the preparation of the estimates rapid and easy and they are found more satisfactory to all concerned than the custom of allowing 20 per cent. when erection is commenced and the balance on completion.

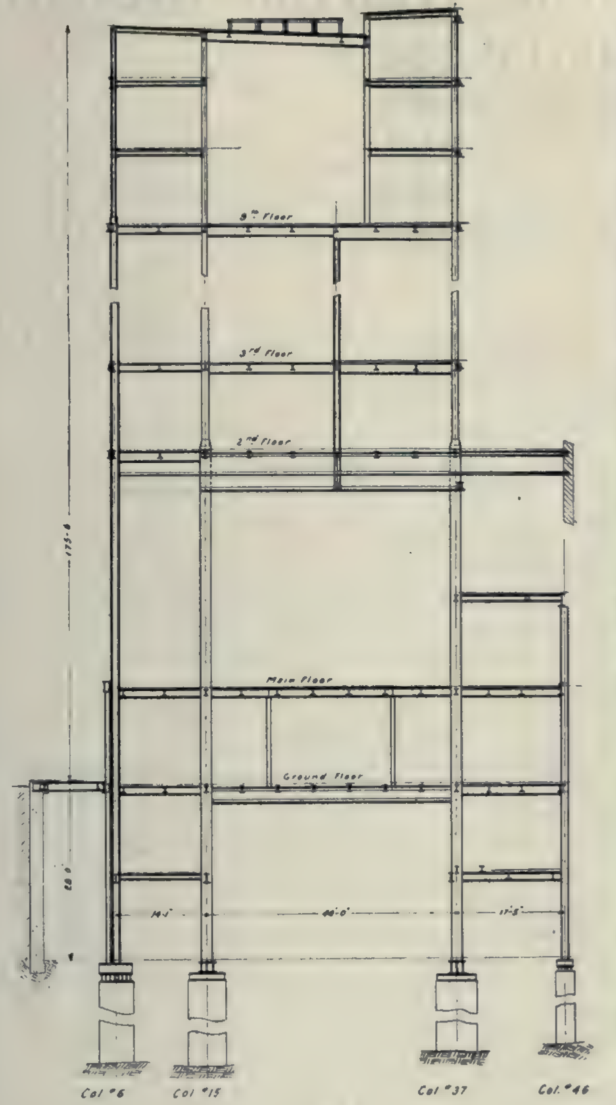


Fig. 2.

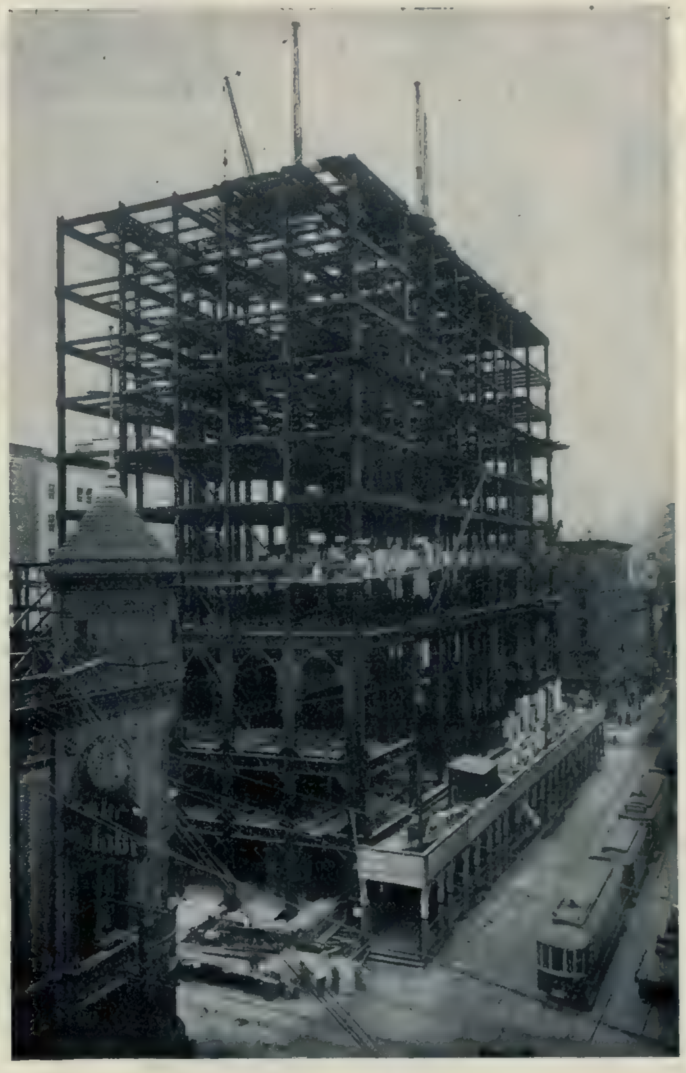


Fig. 5.

Steel Structure of the Dominion Bank Building, Toronto

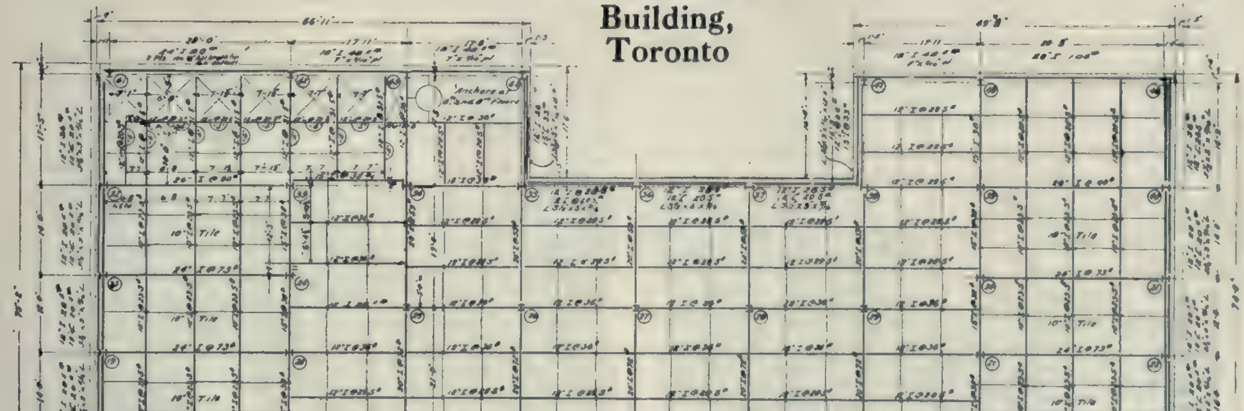


Fig. 3.--Sixth, seventh and eighth floor framing plans.

The Present Status of the Marble Industry in Canada*

By Dr. W. A. Parks, University of Toronto

MARBLE is essentially a decorative stone, in no wise necessary for purposes of construction or indispensable for the life and comfort of a community. Even when used for exterior walls, marble is not recommended on account of either its strength or durability, but solely on account of its superior appearance, or in other words, its decorative value. The use of such material is obviously controlled by two factors—wealth and artistic taste, but the part played by each of these factors is more difficult to determine, for wealth is sometimes ostentatious and artistic taste is too often made the scapegoat of style. Assuming, however, that wealth has been kept in its proper place as the servant of culture, it is interesting to ascertain if the consumption of marble is in accord with the increasing prosperity of Canada. A numerical expression representing the prosperity of a country is difficult to obtain, but subject to criticism, we may regard the total imports and exports as roughly indicative of prosperity, or better, in a country like Canada, the exports alone. The following table shows the imports and exports, the exports alone, the consumption of marble, and the ratio of marble consumption to the total trade and to the exports.

Year (Fiscal)	Impor and Exports	Exports	Marble Consumption*	Ratio of Marble Consumption to total trade	Ratio of Marble Consumption to export
1881	$203,621,663	$98,290,823	$ 85,977	.00042	.00087
1891	218,384,934	98,417,296	109,413	.00041	.0011
1901	386,903,157	196,487,632	96,159	.00025	.00049
1909	571,268,769	261,512,159	359,369	.00063	.0014
1910	693,211,221	301,358,529	343,577	.0005	.0011
1911	769,443,905	297,196,365	470,211	.0006	.0015
1912	874,637,794	315,317,250	661,499	.00076	.0021
1913	1,085,264,449	393,232,057	761,302	.0007	.0019

*The slight exports are neglected. The imports are for the fiscal year and the production for the calendar year.

An inspection of this table shows, in a general way, that the consumption of marble is more than holding its own with the increase of wealth. This conclusion is satisfactory, but there is little reason for congratulation in the figures representing the domestic production as compared with the importation of marble during the same period of time.

Year (Calendar)	Canadian Production	Imports	Ratio of Production to Imports
1881	nil	$ 85,977	.000
1891	$ 1,742	107,661	.016
1901	nil	96,159	.000
1908	125,000	287,587	.43
1909	158,441	182,147	.87
1910	158,779	267,215	.59
1911	162,783	384,252	.42
1912	260,764	475,976	.54
1913	250,373	577,082	.43

Prior to 1908 the production of marble in Canada was insignificant; the industry as a commercial factor dates from the opening of the quarries at Phillipsburg, Quebec, in that year. The production has never equalled the imports and the ratio as shown in the last column above is not encouraging. This unsatisfactory showing has resulted notwithstanding a reasonable protection as indicated in the table of tariffs below:

	British preferential % ad valorum	Intermediate % ad valorum	General % ad valorum
Marble, rough, not hammered or chiselled	10	12½	15
Marble, sawn or sand rubbed	15	17½	20
Marble, manufactures of, not otherwise specified	30	32½	35

By the tariff revision which came into effect on April 7th, 1914, the intermediate duty on sawn or sand rubbed marble was raised to 20 per cent.

An industry only six years old is much too young to bear a close scrutiny and the marble industry is particularly sensitive as it is subject to the pre-conceived ideas of builders and frequently has to combat the prejudices of architects. In other words, the market value of a marble, however beautiful, is not intrinsic as in the case of gold or copper, but is controlled by prevailing styles and other factors too numerous to mention. On the other hand, a desirable stone must eventually win its way into popular favor if it can be placed on the market at a reasonable price and if the all-important matter of advertisement is not neglected. In Canada to-day our own marbles are not as well known as imported varieties and, until the public is thoroughly educated in the matter, there is no hope that the domestic article will make serious headway against imported stones. It must be remembered, however, that under no circumstances can Canadian marble entirely replace foreign varieties, for the use of decorative stone is art, not engineering, and can therefore never be entirely subject to the ordinary laws of supply and demand.

Our figures show that Canadian marbles during the six years of production have not replaced foreign stone to the extent that might be desired, but the explanation does not lie entirely in the considerations given above; it lies rather in the inability of the present producers to fill a large order in stone sufficiently uniform to meet the requirements of architects. Again, and it may as well be freely admitted, many of the Canadian marbles are too hard to be chiselled with facility and are consequently rejected by monument makers in favor of softer stone from abroad. This objection applies with less force to architectural marble, a large proportion of which is prepared without recourse to hand carving. A third cause for the lack of the desired increase in production is the gross misapplication of certain stones, whereby an undeserved bad name is acquired. Without enlarging on this subject it may be stated that no polished marble, domestic or foreign, is a suitable material to expose to the winter climate of Canada and that delicately variegated stones are not adapted to the manufacture of unsupported counters or table tops. A most severe condemnation of a certain Canadian marble came from a workman with shellac pot in hand busy in the mending of a slab of foreign marble. If we are content to back foreign marbles with slate, to bolster them with plaster, and to coax them to hold together with shellac, why should we ignore the doctor and send for the undertaker in the case of a Canadian marble tainted with the same disease?

---

* Published by permission of the Director of the Mines Branch, Department of Mines, Canada.

The first and most important question in connection with the marble industry is to determine if marketable stone occurs in the country; the first stage of this inquiry is the locating of possible sources of supply. In eastern Canada marble occurs under three conditions which must be considered in a review of the subject:—first, in the great crystalline complex; second, in less disturbed, but marmorized limestone of later age; third, in narrow bands associated with altered rocks of various ages.

Marbles of the Ancient Crystalline Complex

The great area of crystalline rocks, which forms the major portion of northern Ontario and Quebec, contains numerous bands of marble which stretch in a northeast and southwest direction and occur from the vicinity of Renfrew to beyond Three Rivers. These marbles are of very ancient origin and are associated with gneisses and other hard crystalline rocks. Under similar conditions occur the marbles of South Stukely, Quebec and those of the island of Cape Breton. The normal stone of these deposits is a coarse grained white or blue-banded type, which is frequently charged with quartz, interbanded with impurities or rendered undesirable by reason of indifferent color. In many places, however, the stone is of desirable quality for building purposes, and in others it possesses the requisite grain and beauty to lift it into the class of decorative marbles. There can be no question that highly desirable marbles of this class occur; but it must be remembered that a wide difference exists between a pretty specimen and a marble quarry. Conditions must be met which are too often overlooked by enthusiastic prospectors. In the first place, the stone must be of reasonable uniformity and it must occur in sufficient quantity to justify quarrying operations. Secondly, the formation must not be so shattered as to prevent the extraction of quarry blocks without undue waste; for ordinary decorative marbles, the formation should permit the extraction of blocks 4 ft. x 4 ft. x 6 ft.

The marbles of this class in the Maritime Provinces have suffered severely from fracturing, so much so, that all attempts to work them have met with failure although some beautiful varieties occur near St. John. in New Brunswick and at Marble Mountain, River George, Eskasoni, Whycocomagh and other points in Cape Breton.

The marbles of the crystalline areas in Ontario and Quebec are much less shattered than those of the Maritime Provinces and blocks of the desired size can doubtless be obtained at many places. The following table presents a rough classification of these stones and indicates the more common localities of occurrence.

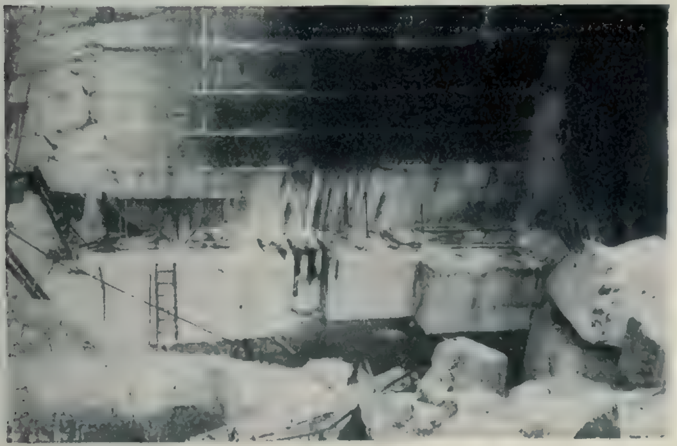
I. White Marbles—
    Haleys, Renfrew County, Ont.
    Portage du Fort, Pontiac County, Quebec.
    Township of Barrie, Frontenac County, Ont.
    Township of Dungannon, etc., Hastings County, Ont.

II. Variegated Marbles—
    (a) Blue-clouded or banded marbles.
        i—Fine grained and delicate.
            Calabogie, Renfrew County, Ont.
            South Stukely, Quebec.
        ii—Coarse banded or clouded, light.
            Renfrew, Ont.
            Fitzroy Harbour, Ont.
            Portage du Fort, Quebec.
            St. Saveur, Quebec.
        iii—Coarse clouded or banded, dark.
            Arnprior, Ont.
            South Stukely, Quebec.
        iv—Blue predominating.
            Actinolite, Hastings County, Ont.
            Lanark Village, Ont.
            Portage du Fort, Quebec.
            South Stukely, Quebec.
        v—Very dark (black marble).
            Madoc, Ont.
    (b) Coloured Marbles:
            Township of Dungannon, etc., Ontario.
            South Stukely, Quebec.
            Ste. Thecle, Quebec.
            Garden River, Ontario.

III Serpentine Marbles:
    Township of Darling, Lanark County, Ont.
    Township of Grenville, Argenteuil County, Que.
    Township of Melbourne, Richmond Co., Que.

The White Marbles

The marbles of Portage du Fort and Haleys are coarse in grain but uniform in color and structure; they occur in large quantity and under conditions which should render quarrying easy. These stones will probably find their chief application as high grade building material. Two companies are at present en-


Channelling machines at Dominion Marble Company's quarry, South Stukely, Que.

Disposition of beds in quarry of Missisquoi-Lautz Corporation, Phillipsburg, Que.

gaged in work preparatory to placing the stone on the market.

The marble of Barrie is beautifully white and fine in grain, but it is marred by large included crystals of foreign minerals and is situated at too great a distance from a railway.

The Dungannon white marbles are of medium to fine grain and show slight shades of different colors. Many of these stones look very promising, but their commercial possibilities are not yet thoroughly established.

The Blue-banded Marbles

Nearly all the blue and white-banded marbles are of coarse or medium grain and are well adapted to building; they may, of course, be used for decorative purposes, but, as a rule, the coarse grain is not offset by any particular beauty. The fine grained and delicate stone from Calabogie, and some of the varieties from South Stukely, are exceptions. The very dark marble of Madoc may eventually prove valuable for certain purposes.

Pontiac Lime Company's plant at Portage du Fort, Que.

The Colored Marbles

Highly ornamental variegated marbles, in varieties too numerous to mention, are quarried by the Dominion Marble Company at South Stukely, Que., and by the Ontario Marble Company at Bancroft, Ontario. A third firm, the Canadian Marble Company, has acquired properties near Bancroft and will shortly enter the field. Up to the present a greater measure of success has attended the quarrying of this type of stone than has resulted in the case of the other marbles of this class. Many of these colored marbles are in every way desirable and meet all the demands of beauty, durability, size and susceptibility of polish. The one great difficulty, a difficulty inherent in variegated stones, is that of too much variation. These colored stones run in bands of limited width with a highly inclined or vertical dip. The bands vary within themselves and, moreover, they are not strictly bands, but lenses, which may fail or alter in character with depth. Now, in many cases, an extensive quarry cannot be worked on a single band and in consequence several bands must be quarried at once. It is apparent, therefore, that a stated variety is raised in small quantity only by the removal of each successive floor. The less desirable bands or those less in demand must be raised also and if this product is not marketed, or if the company is unable to carry a large reserve stock, operations are of necessity suspended. Experience seems to show that marble quarrying can be successfully carried on only by means of large plants and modern machinery. A second necessity in the case of these variegated stones is the accumulation of stocks of sorted material. Nothing has done more to shake the confidence of architects in our colored marbles than the difficulty experienced in having orders filled, in a given variety, within a reasonable time. The solution of this difficulty seems to lie along many lines. The following suggestions are made in the hope that operators may find in them something of advantage.

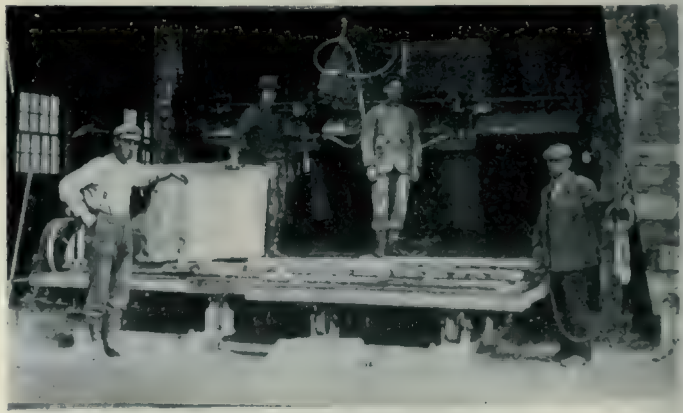
1. Companies should not advertise too many varieties, when they must themselves know of their inability to supply them in quantity.

2. A big local quarry with a fixed plant labors under the necessity of quarrying a large amount of material of less desirable character in order to procure a small amount of a variety in demand. While operations on a large scale are necessary for successful competition, it may be that the large quarry is not the best adapted to the exploitation of these variegated (and variable) stones. A more flexible plant with portable units, capable of following the desirable bands along the strike, might perhaps meet the conditions in a more satisfactory manner.

3. The question naturally arises "Is the total consumption of colored marbles in Canada sufficient to warrant the installation of a plant large enough to make possible the successful competition with foreign marbles?" While I am unable to answer this question I am, nevertheless, certain that many of our marbles are sufficiently attractive to win their way in the foreign market. The United States duty on rough blocks is 50 cents per cubic foot. This is not an impossible barrier against material which could be marketed in New York at from $5 per foot up.

The Serpentine Marbles

Beautiful serpentine marbles in green and white, lavender and green, and in yellow and white have been quarried by the North Lanark Marble Company, in the Township of Darling. This company is now awaiting the completion of a railway before resuming operations, which have been suspended for some time.



Diamond saw at Pontiac Marble & Lime Company's mill, Portage du Fort, Que.

The serpentine marbles of Grenville and those of Melbourne and Cleveland in Quebec have never reached economic importance.

Marbles of the Sedimentary Series

Limestone, formed by sedimentation in the ocean, is one of the commonest rocks of Ontario and Quebec. In some places these limestones have been converted into marble by the action of heat and other agencies. The more important localities at which marbles of this type occur are at Phillipsburg, Dudswell and Port Daniel in the province of Quebec. The two latter localities are of no present economic importance, but at Phillipsburg, the Missisquoi-Lautz Corporation is operating the largest quarrying plant in Canada. The marble belt is very extensive and is composed of beds of limited thickness disposed at a slight angle with the horizontal. These marbles consist mostly of grey and green mottled varieties, with some more highly colored examples. An expensive and efficient quarrying plant is provided which controls the site of the present quarry. As the beds vary in character and are nearly horizontal in position, it is apparent that quarrying operations must soon remove the whole of a given variety (bed) throughout the area of the quarry. Therefore, the same difficulty is encountered which was referred to in the case of the marbles of the first class, i.e., the continual production of a stated variety is not easy under the conditions prevailing in the quarry. It would appear, however, that an abundance of the more popular stones is available; the corporation will doubtless devise methods of quarrying which will result in a continual output of the varieties in demand.

Marbles of the Third Type

Associated with the stratified sandstone, limestones, shales and other rocks in the metamorphic regions of Quebec and the Maritime Provinces, are narrow bands of brilliantly colored and variegated marbles of indisputable beauty. Much has been said as to the possibilities of these deposits, but it must be admitted that any attempts at quarrying have not met with success. The reason seems to lie in the shattered condition of the outcrops and the limited amount of desirable material exposed. The more important localities at which stone of this type occurs are near St. Joseph on the Chaudiere River, above Richmond on the St. Francis and in Orford Mountain in Quebec, and on the St. John River above Hampstead in New Brunswick.

In British Columbia

Throughout the above remarks no mention has been made of British Columbia, but that province has contributed somewhat to the total production of marble in Canada. Marble has been worked by the Canadian Marble and Granite Company, near Lardo. The stone is rather coarse in grain and presents shades from white to dark blue. The formation is very solid and blocks of any desired size can easily be obtained. The Nootka Marble Quarries Company has obtained a blue-grey marble with whitish markings from its quarries on Nootka Sound. Marble quarrying on the coast does not seem to have met with great encouragement, as the production in 1909 was $25,000; in 1910 it was $5,679; it fell to $1,600 in 1911 and to nothing in 1912.

The great Ashokan aqueduct to supply the city of New York, now in course of construction, is the only modern hydraulic enterprise intended mainly for domestic and industrial use, that compares fairly with the Los Angeles aqueduct. The New York aqueduct crosses the Hudson over a thousand feet beneath the river bed, and it will furnish the metropolis with 500,000,000 American gallons daily at a cost, including its various reservoirs, of, roughly, $170,000,000. The Los Angeles aqueduct has not much more than half the capacity of the Ashokan; but it is about twice as long, passes through an incomparably rougher country, and its cost, when completed, will, it is said, be less than one-fifth that of the great New York enterprise.

Miscellanea

Nitrogen over 1 sq. mile of the surface of the earth is estimated to be sufficient to supply the whole world with fertilizer for fifty years at the present rate of consumption. To produce nitrate fertilizer from the air to an amount equal to that now used by the civilized world would require an investment of $860,000,000.

Mrs. Victor Garnish, who was for twenty years a licensed engineer in Minnesota, applied last month to take out a license in Regina to run her husband's traction engine, but the Saskatchewan law allows male engineers only. She says there are many women in the province who would become engineers if they could.

Foundation work has commenced on the Arts Building at Edmonton, Alta., which is to be erected for the University of Alberta at a cost of $500,000. The contractors are Messrs. Geo. A. Fuller & Company, Limited, Winnipeg. The structure will be four storeys high, 60 ft. by 375 ft. in dimensions, of brick and stone construction.

The durability of reinforced concrete poles was amply demonstrated during the past winter in the experience of one of the railroads, which has been making an experimental test of these poles. During severe storms the poles of this company were severely taxed and in many cases the overloaded wires bore their supports to the ground, but in no instance did a concrete pole fall, although in several cases the weight was so great as to break the wooden arms carrying the wires

---

A case of interest to contractors generally was heard before Mr. Justice Panneton in Montreal on May 1, when The Canadian Spool & Cotton Company sued the well-known firm of building contractors, Messrs. Peter Lyall & Sons, and Messrs. Brown & Vallance, architects, the cause of action being "dry rot" which was alleged to have attacked and considerably depreciated a building erected for the plaintiff by Messrs Lyall under the direction of the architects. The primary cause of the damage was alleged to have been the employment by the contractors of a quality of wood other than and inferior to that called for in the architects' specifications, according to which latter the contractors undertook to supply "all timber, Georgia pine, long leaf, straight grain, free from knots." That they failed to do so, except in small quantities, was admitted, the reason given being that it was found impossible to obtain the required quantities otherwise than at prohibitive prices as the lumber would have to be picked at different mills. It was contended on behalf of the contractors that a good merchantable grade of wood was used. The dry rot was discovered only after the plaintiff had been in full possession of the building for nearly a year. The wood used did not appear to have the same resisting ability to the dry rot germs as that required in the specifications, with the result that the plaintiff was forced to renew and replace with steel the beams throughout the structure, the expense incurred in this operation totalling about $91,000. His Lordship gave judgment for the plaintiff for $71,120. It is intimated that the case will be appealed.

Waterproofing—Its Early History and the Development of Modern Methods

By W. H. Evans[*]

WATERPROOFING is divided into two classes—membrane waterproofing and integral waterproofing. The early history of waterproofing is clouded in mystery, there being little or no literature on the subject.

The first successful waterproofers were the Romans, and they were also the first successful manufacturers of cement. Waterproofing consisted primarily in building foundation walls so thick that it was difficult for water to penetrate them. At the time Caesar invaded Gaul, about 2,000 years ago, the Romans found a mineral (now known as cerusite) from which they obtained lead. The metal was too soft, however, for technical use, but they soon discovered on rolling it into thin sheets, that it corroded only on the surface.

Sheet lead has been found the most suitable material for conveying water, for the reason that the white scum which forms on the surface does not go any further. This scum is an oxide which seems to protect the lead underneath it. Iron pipes which are used for conveying water rust out completely in time. We are thus indebted to the Romans for the real introduction of waterproofing foundation walls.

During feudal times the method of protection practised by the ancients was to build castles surrounded by moats. These moats were huge ditches filled with water spanned by a drawbridge. When the enemy approached the castle the bridge was drawn up, thus isolating the inhabitants and making them invulnerable. The ancient Britains and Normans soon found that water penetrated into the cellars or dungeons of the castles. When these dungeons were used for prison purposes, they cared not whether they were wet or dry, but it was found later on that the seepage undermined the foundations, which necessitated waterproofing them. In some cases this was accompanied by the use of sheet lead, in others with huge stones laid up in cement, but the latter did not prove effective.

The Membrane Method

The membrane method of waterproofing has been used, in one form or another, for a considerable period, but the use of concrete and stucco in modern construction has led to a realization that the Integral Method of waterproofing is the proper one to adopt. Waterproofing therefore became divided into two classes as stated, membrane waterproofing and integral waterproofing.

Membrane waterproofing is of two classes, known as hot and cold applications. The hot application being the better method of the two, originally was only done with one or two coats of a waterproofing compound—either coal tar or asphalt—but was found to be inefficient in some respects. In order to strengthen the waterproofing and overcome its defects, the addition of waterproofing compound and one layer of felt and another coating of waterproofing compound was made. The specifications gradually grew until at the present time nothing less than three ply of waterproofing is considered. This is gradually increased to as many as seven or eight ply, depending entirely upon the water pressure and the depth of the structure.

The reason why the felt was added was to strengthen the waterproofing compound, as it responded to the temperature changes very quickly. In cold weather the waterproofing compound hardened to such an extent that it became brittle, and disintegration of the compound under such a condition was rapid. In warm weather when the temperature was at its highest it did not set up hard enough, consequently it was very easily scraped in places by the back fill, particularly if the latter was coarse and contained refuse from the building, thereby causing considerable trouble through leakage. To overcome this, therefore, the addition of a felt was deemed advisable.

In the other method of construction of foundation walls, either of stone or brick, the general custom has been first to lay up a course of four inches of brickwork about five feet high, then apply the waterproofing as prescribed in the specifications, and immediately back up by brick or stone work of such thickness as the specifications call for.

Architects early recognized that a straight line of waterproofing from the footing to the water table meant a weakening of the structure. It threw the entire weight of the building upon the inner wall, because the line of waterproofing did not allow the outer veneer to combine the inner wall sufficiently strong to make it carry its proportion of the weight of the building. Consequently the specifications were changed so that the waterproofing was run up five or six feet perhaps on a straight line. It would then carry it into the wall about eight inches at right angles and along the outside of the wall for about eight inches, back again to the original line of waterproofing. Waterproofing contractors soon pointed out to architects and engineers that every time a turn or angle was made it increased the danger of a leak; but as nothing better was suggested it was generally accepted as the best solution of the problem. Their attention was also called to dampness in the walls due to various causes, mainly to the brick or stone being first wetted down before being put in the wall and to capillary attraction, which made it almost impossible to get a perfect bond between the waterproofing and the wall. The contractors also found considerable difficulty in getting a perfect bond between the waterproofing and the wall, because of difference in temperature, as it was necessary to apply the waterproofing compound at a temperature varying from 200 to 250 degrees. The temperature on the walls at no time was higher than 90 to 100 degrees. The difference in temperature between the wall and the material invariably had a tendency to chill the waterproofing compound at the point of contact.

These drawbacks having been recognized, architects, contractors, and engineers began looking for a different method, and finally hit upon the idea of a cold application which could be put on the surface at a temperature where both materials and surface were about equal. Several manufacturers of waterproofing compounds next produced materials which could be applied cold and which possessed sufficient tackiness to make the felt adhere. The majority of these materials being composed of waterproofing compounds with a volatile solvent, the rapid evaporation of which caused the compounds to harden quickly and thereby lose some of its adhesiveness, it was found next to impossible to carry up two layers of the felt. In order to overcome this burlap was gradually introduced in place of the saturated felt. The number of layers was reduced to an application of waterproofing compound, one layer of burlap and a finish coat of waterproofing compound.

---

[*] Waterproofing Engineer, Dartnell Limited, Montreal

In the early stages of waterproofing with the ground adoption of a combination of compounds and felts, the danger from abrasion and punctures due to back fill was recognized. Where a coating of that kind was specified to be carried up on the exterior of the wall, which was sometimes done in order to maintain the full strength of the foundation wall, a safety coat of cement mortar was specified to be applied immediately on top of the waterproofing compound. This was to act as a safeguard against abrasion by the back fill.

With the introduction of concrete in foundation construction, the straight smooth line from the footings to the water table presented some difficult problems, among which was the trouble in getting proper adhesion for a waterproofing, as concrete construction being laid up in forms made it impossible to key it into the wall. A substitute for this was looked for, with the result that manufacturers catering to that class of business gradually produced materials which were structure waterproof. This was introduced as the "Integral Process." It seemed to be the ideal thing and was generally recognized as a proper solution of all previous waterproofing troubles.

Integral Waterproofing

Integral waterproofing is based upon four theories, each theory being advanced by the manufacturer of a specific compound, and I will classify them as A. B, C and D.

In class A theory, the manufacturer claims that by the introduction of two per cent. insoluble matter into the body of concrete evenly distributed throughout the mass by a mechanical operation, and then cast in form, a physical force develops which drives the insoluble matter during the process of crystalization of the cement into the voids, and in that way waterproofs the concrete.

The second theory is advanced by the manufacturer in class B. His view is that in order to waterproof concrete properly it is necessary to lubricate, thus avoiding the voids. His idea of lubricating the concrete mass is to introduce into the concrete an emulsion. He believes that the action resulting from the mix of cement, water and emulsion will sufficiently lubricate the mass so as to bring about a close, compact body of concrete.

The manufacturer who advances class C theory claims that cements are not wholly colloidal, and that the coarser and non-colloidal particles of cement must be made colloids. He does this by the introduction of his material, and by producing this condition preserves the physical construction of cement in its entirety, and brings about 100 per cent. of efficiency in the action of the cement in concrete construction. Doubtless the manufacturer of class C theory understands fully one of the drawbacks in concrete construction. Therefore he claims to have produced something which fills one of the defects in the construction of cement by the introduction of his material. The fact remains, however, that the so-called non-colloidal particles of cement are mostly of a clinker nature, and if such action is produced in the clinker it is my belief that an ultimate reaction is bound to result. If a reaction does take place it should receive the consideration of the architect and engineer who specifies such a material.

The manufacturer in class D theory agrees with the manufacturer in class A that voids in concrete will occur. He also recognizes the necessity for lubricating the mass as claimed by the manufacturer in class B. At the same time he recognizes the importance of the theory advanced by the manufacturer of class C that the physical construction of cement in its entirety must be put into the concrete mass. He has therefore manufactured an article which he claims to be waterproof concrete. His theory is that while recognizing that the cement is not 100 per cent. colloidal, it is necessary to lubricate it. He also feels it is impossible to fill the voids in concrete by the theory advanced in class A. The material which he adds to the concrete is a colloid of the same nature as cement but of a much higher percentage, claiming that by reason of the introduction of the material that he manufactures, he carries into the cement the full 100 per cent. of efficiency, and by introducing an additional colloid increases the cohesion of the cement, thereby lubricating it sufficiently to produce a close ground body made of cement, sand, gravel or stone.

The writer believes it to be possible to make concrete absolutely waterproof without introducing any waterproofing compound. At the same time he is convinced that conditions on the field make it impossible at all times to do this. While it has been demonstrated in laboratories that a concrete made even of a 1-3-5 mix can be made absolutely waterproof without the introduction of any waterproofing compound, such results have not been achieved in field work. The introduction of a material that will assist materially in producing that condition is therefore absolutely necessary. The importance of waterproofing concrete becomes more apparent on account of the expansion and contraction of concrete due to the absorption and evaporation of moisture.

Having gone over the question of waterproofing of the different types, having classified it in its different theories, the reader will agree that, having transplanted concrete from a substructure proposition to a superstructure proposition, it becomes necessary to take precautions to avoid extreme expansions and contractions. It is the duty of architects, engineers and cement users to select for themselves that which they consider will best answer their purpose.

A new station estimated to cost $250,000 is to be erected at Calgary, Alta., by the C. N. R. Plans have been completed and operations are to commence in June.

A new customs house estimated to cost $400,000 is to be erected at Ottawa this season for the Dominion Government. The foundation work is now in progress, the operations being carried on by the Foundation Company, Limited, of Montreal.

The Forthcoming International Road Congress at Montreal

SOME 30,000 invitations to the first Canadian and International Good Roads Congress, to be held in the Arena, Montreal, May 18 to 23, have been sent out, and the replies indicate that representatives from all parts of the Dominion will be present. Many of the speakers are recognized as authorities on the subjects to be discussed, which will cover the entire field of road construction, maintenance, and appliances. Those attending will have the benefit of the experience of men who have a practical as well as a theoretical knowledge, and who have tried out many systems and methods. Highway legislation is one of the questions which will be discussed, while technical training in road building, not only on the American Continent but in Europe, will be another subject which will come under review.

Mr. U. H. Dandurand, Chairman of the Congress.

Canada is spending, and will continue to spend for many years, very large sums on new roads and on improving existing highways, and it is essential that we should have the means of securing the best technical education if the expenditure is to give the most economical results. There is also a pressing need for educating the inhabitants of the rural districts along the lines of the good roads movement—its value from the point of view of affording easy communication between various localities and also from the standpoint of productive expenditure. Men in the agricultural sections in particular are reluctant to expend money on roads unless direct benefits can be shown, and the movement is doing good work in pointing out the immediate and future good results which accrue from a liberal expenditure on highway improvements. In some instances where the construction of roads will materially aid communities there is a reluctance to spend money; as an example, the opposition of some municipalities to the Roads Bill of the Quebec Government may be cited. Here the Government offered the most liberal terms, with a very low rate of interest, in order to induce municipalities to put in order their roads, but notwithstanding, exceptions were taken to the provisions of the Bill.

It may be broadly stated that the most progressive councils are those with the best kept roads under their jurisdiction. It does not follow that the most lavish expenditure gives the most economical results, and it is one of the main objects of the Congress to indicate how money can be spent to build the best and most permanent roads. The papers to be read are of so varied a nature that the needs of practically every locality will be dealt with, and engineers of municipalities will be able to secure data which will prove of value in the laying out of roads.

Apart from the papers which will be contributed, the exhibition of road material and machinery should prove of interest. It will include materials of practically every well known type, while the machinery will embrace appliances of every kind used in the construction and maintenance of highways. The manufacturers will have, during the evenings, opportunities of explaining by means of moving pictures, the uses and advantages of their products. The Ontario Government will loan models of roadways of various countries, some of the very earliest types. These models will illustrate how roads are built up, and will indicate the progress which has been made during recent years.

The speakers will include—Sir Francois Langlier, Lieut.-Governor of the Province of Quebec, who with Sir Lomer Gouin, Premier of Quebec, will open the Congress; Honourable G. Tessier, Minister of Roads, Province of Quebec; W. A. McLean, M. Can. Soc. C. E., Chief Engineer of Highways, Department of Public Works, Province of Ontario, and President, the American Road Builders' Association; Paul D. Sargent, Chief Engineer, State Highway Commission, Augusta, Maine; Dr. E. Merrill Desaulniers, M.L.A., Chambly County, Que.; E. A. James, B.A.Sc., Consulting Engineer and Engineer Board of Highway Commissioners, York County, Toronto, Ont.; J. W. Levesque, M.L.A., Laval County, Que.; Walter W. Crosby, C.E., Consulting Engineer, State Highway Commission, Baltimore, Maryland; Lt.-Col. W. N. Ponton, President, the Ontario Associated Boards of Trade, Belleville, Ont.; O. M. Hezzlewood, President of the Canadian Automobile Federation; Jean de Pulligny, M.A.S., C.E., Chief Engineer of the French Government's Civil Engineering Service; H. W. Pillow, Chairman Good Roads Committee, Canadian Automobile Federation, and President, Automobile Club of Canada, Montreal, Que.; William H. Connell, Chief of Bureau, Department of Public Works, Philadelphia, Pa.; A. T. Laing, Professor, Faculty of Applied Science and Engineering, University of Toronto, Ont.; Arthur H. Blanchard, Professor of Highway Engineering, Columbia University, New York City; T. Hugh Boorman, C.E., Treasurer, American Society of Engineering Contractors, New York City; R. A. Meeker, Engineer, Dept. of Public Roads, State of New Jersey, Trenton, N.J.; C. L. Shorey, Chairman, Road Committee, Town of Beaconsfield, Que.

The officers of the Congress are U. H. Dandurand, Chairman; Horace Joseph, vice-chairman; and Geo. A. McNamee, general secretary. Executive committee: U. H. Dandurand, O. M. Hezzlewood, H. W. Pillows. Reception Committee: H. H. Learmont, Chairman; W. A. McLean, Dr. E. M. Desaulniers, M.L.A., J. W. Levesque, M.L.A., Frank G. Carrel, L. C. Rivard, Honore Mercier, M.L.A., C. P. Beaubien, L. E. Geoffrion, Hon. Geo. R. Smith, F. H. Anson, A. Berthiaume. Entertainment committee: J. A. Davis, Chairman; J. Davidson, A. L. Caron, H. W. Pillow, Controller Duncan McDonald. Publicity Committee: Eug. Tarte, Chairman; J. Vernon McKenzie, W. G. Robertson. Exhibition Committee: E. W. Sayer, Chairman; W. H. Leach, Geo. A. McNamee.

Constructional News

The Quebec Highway Commissioners have awarded to Messrs. O'Brien & Doheny the contract for a stretch of road 33 miles long. The price was $224,000.

The County Council of Oxford, Ont., has decided to expend $320,000 on a system of county roads with the proviso that only $60,000 shall be spent in one year.

The Welland County Council extends an invitation for tenders until May 23 for thirty-four miles of macadam road construction, the estimated cost of which is $153,000.

At Saskatoon, building operations are to commence shortly on a four-storey apartment block estimated to cost $150,000. The prospective owner is Anthony Le Jeune, of Saskatoon.

The sewage disposal plant at Morley Avenue, Toronto, which involved an expenditure of $800,000, is to be replaced by the Imhoff tank system at an estimated cost of two and a half million dollars.

The plans for the new Union Station at Toronto have been finally approved and work on the new structure will be started in three months, the period allowed for receiving tenders and awarding contracts.

Swift Current, Sask., is to have a courthouse at an estimated cost of $125,000. Tenders for the erection of the building are now being received by the Department of Public Works of the Provincial Government.

Replying to a question by Mr. Lemieux in the House of Commons a few days ago, as to whether tenders had been asked from Canadian firms for the construction of new equipment recently secured in Great Britain by the Quebec Harbor Commission, Hon. J. D. Hazen stated that tenders had been invited from several Canadian firms, all of which were higher than the accepted tender.

Plans which have been approved this year by the C. N. R. management provide for the construction of yard trackage to store and manipulate 10,000 freight cars and 1,000 passenger coaches. Trackage, round-houses, shops, tool-working mills, turning and moulding shops are provided for in the scheme which the company are planning for the extensions of their terminal facilities at Port Mann, B.C.

The St. John Board of Trade have recently been investigating the possibilities of opening up trade with South America, particularly the Argentine. Trade Commissioner Pousette, who recently interviewed the Board of Trade on the subject, expressed the opinion that trade might be developed satisfactorily along the lines of agricultural implements, nails, automobiles, railway rolling stock, edge tools, stoves, furniture, etc.

Building developments throughout New Brunswick are very active at present, particularly at St. John where several large buildings are in progress. The Canadian Pacific Railway Company has already entered into contracts for the rebuilding of the Algonquin Hotel which was burned down recently at St. Andrews. The new building, which will be completed next year, promises to be one of the finest yet constructed for the company.

The Dominion Railway Board has reserved judgment on the question of apportioning the cost of the North Toronto grade separation and viaduct. The contention of the C. P. R. is that the city should contribute half the cost of the work, while the city's argument is that the entire cost should be borne by the railways, the city's streets having the prior right-of-way. The proportion of the cost in which the city is asked to share is $1,500,000.

The building permits issued in Montreal during April totalled 527 in number and in value $2,205,970, against 450 permits of the value of $3,322,406 for the corresponding date last year. From January 1 to April 30 of the present year, 1,107 permits of the value of $4,061,166 were issued. This is 185 permits ahead of the corresponding period in 1913 but more than $29,000 less than the value of the permits issued during the first three months of 1913.

Messrs. Parks, Tupper & Kirkpatrick, contractors for the new Marine & Fisheries wharf on the Songhees Reserve, B.C., have started preliminary operations with the driving of piling on the foreshore area. The contract calls for the erection of a creosoted pile wharf, 644 ft. in length, and the excavation and levelling of about 27,000 cubic yards of clay subsoil. The foreshore site is the one on which it is intended to erect the new Marine & Fisheries building, plans for which are now being made at Ottawa.

The number of building permits issued from the office of Mr. S. N. Jarrett, Building Inspector, Vancouver, for April, 1914, is considerably below that of the corresponding month last year. In the latter period 217 permits representing in value $1,103,352 were issued, as compared with 141 permits to the value of $254,166 for April of this year. The total number of permits issued during the four months of 1914 was 558, representing a value of $1,296,604, against 801 permits and $5,179,715 in the corresponding period last year.

Personal Mention

Mr. Thos. Daley, a well-known Toronto contractor for the last half century, died on May 3 in his 88th year. He was a native of Youghal, Ireland, and came to Toronto in 1851.

Mr. Wm. Wainwright, senior vice-president of the Grand Trunk Railway, celebrated his 74th birthday on April 30. Mr. Wainwright began his railway career in 1838 as junior clerk and joined the Grand Trunk Railway in 1862. He is a native of Manchester, Eng.

Mr. W. W. Pearse has been appointed City Architect of Toronto at a salary of $5,000 a year. Mr. Pearse is a native of Toronto, where he graduated more than twenty years ago. He has had considerable experience in architecture and engineering for many years in New York.

Mr. T. P. Howard, Managing Director of the Phoenix Bridge & Iron Works, has been elected Chairman of the Montreal Branch of the Canadian Manufacturers' Association. Among the executive committee are Messrs. B. W. Coghlin, of the B. J. Coghlin Company; Percy S. McKergow, National Brick Company of Laprairie; and R. H. McMaster, Steel Company of Canada.

Major Garnet B. Hughes, son of Col. the Hon. Sam Hughes, has been appointed Government resident engineer for Vancouver Island. Major Hughes is a graduate of the Military College, Kingston, and has been employed under the MacKenzie-Mann Electric Railway at Victoria. There will now be two resident engineers on the Island. The work being carried on in Victoria Harbor is under the supervision of Mr. F. J. McLachlan, while Major Hughes will have charge of the remainder of the work on the Island.

The Tiffin Wagon Company, of Tiffin, Ohio, are issuing a fine new illustrated catalogue describing their new Tiffin Model "A" ten-passenger park and sight-seeing car. There are few builders of cars of this type. Experts pronounce the new Tiffin product to be one of the finest of its kind on the market.

Messrs. Lecky & Collis, Limited, have removed to 49 Beaver Hall Hill, Montreal. The Laurie Machinery Company, Limited, are occupying the premises vacated by Lecky & Collis, at 335a Craig street west.

Head Office and Works, General Car and Machinery Company, Montmagny, Que.

The Industrial Expansion of a Prominent Quebec Firm

The General Car and Machinery Works, Limited, Montmagny, Que.

The General Car and Machinery Works, Limited, whose main office and plant are situated at Montmagny, Que., was formed in 1912 with a capital stock of one million dollars. The company was organized to manufacture machinery and more particularly road-making machines, it being an amalgamation of the Charles A. Paquet Company, Limited, Quebec, and the Montmagny Manufacturing Company, Limited, Montmagny. Both these firms had many years' experience as manufacturers of high-grade machinery and the amalgamation has been eminently successful.

In the possession of technically-trained men at the head of affairs, well-balanced organization and skilled labor, the company have at their command all the essential elements of a big organization. Their plant is of modern design and the firm enjoy unexcelled facilities for manufacturing. They have added to their various departments a steel foundry, which makes them dependent on no other firm for their material.

The President, Mr. Charles A. Paquet, started business on his own account twenty years ago. The rapid growth of the business soon necessitated extension of management and capital. In 1902 he formed a company called The Charles A. Paquet Company, Limited, of which he was president and manager until 1912, when the firm merged with The General Car and Machinery Works, Limited. He has been promoter and organizer of many industrial companies, in several of which he has held the position of president and director.

Mr. Ernest Roy, K.C., the Vice-President of the firm, is interested in many important business undertakings. For

Mr. Chas. A. Paquet, President. Mr. J. H. Paquet, Secretary and Treasurer. Mr. Ernest Roy, K.C., Vice-President.

Officers of the General Car and Machinery Company, Montmagny, Que.

years he was president of The Montmagny Manufacturing Company, and he had charge of the legal work involved in the organization of the new company.

Mr. J. Henri Paquet, Secretary and Treasurer, is a younger brother of Mr. Charles A. Paquet, of the firm of Charles A. Paquet, Limited. His extensive experience was a valued factor in the organization of The General Car and Machinery Works, Limited.

Mr. A. N. Normand, the firm's manager, at an early age acquired a reputation as an inventor of machinery. In 1896 he started a small machine shop at Montmagny. The business grew with remarkable rapidity until the enlargement of the plant became necessary. In 1902 he founded The Montmagny Manufacturing Company, Limited. The excellence of the products of this firm were proved time and again in competition with machinery of the highest grade manufactured elsewhere. Simultaneously with the coming in line of road-making machinery, the Montmagny road-making outfits were placed on the market, and have succeeded ever since in maintaining a high standard. Mr. Normand was managing director of the Montmagny Manufacturing Company from its inception until its amalgamation with The General Car and Machinery Works, Limited.

The Tiffin Wagon Company, Tiffin, Ohio, have just delivered three street flushing machines to the city of Ottawa The order was obtained through the firm's Canadian agents, Messrs. Francis Hankin & Company, Montreal.

One of the most interesting engineering feats of modern times—the raising of the U. S. battleship Main in Havana harbor, is described in detail in an interesting booklet issued by the Lackawanna Steel Company, for whom Messrs. H. A. Drury Company, Limited, Montreal, are the Canadian agents Lackawanna steel sheet piling was employed in the above undertaking.

The Nobis Engineering Company, of Toronto, engineers and contractors, have secured the contract for the "Welo" system of atmospheric pressure steam heating of the new building on Victoria Street, Toronto, for the United Typewriter Company. The Nobis Company are also installing the heating and power plant systems in the new Toronto factory of the National Cash Register Company.

A booklet showing the increased use of Bitulithic pavement in the United States and Canada is issued by Messrs. Warren Brothers Company from their executive office, 59 Temple Place, Boston, Mass. This publication contains many chapters of interest to municipal men and is well worth careful perusal. Extracts from the leading technical journals on both sides of the line are given, the Contract Record being quoted at length in an article, "Bitulithic Paving Construction in Western Canada," published in our issue of January 29, 1913. The development of Bitulithic pavement is shown by the fact that in the year 1901 seven cities possessed 16,400 square yards, while at the end of August last year there were nearly 7,000,000 square yards laid and under contract in 128 cities. Commissioners of works, city engineers, street superintendents and others attest the satisfaction which this pavement has given under exacting requirements.

The "Garrow" contractors' acetylene flare light has just been placed on the market by the Sudbury Construction and Machinery Company, Limited, of Sudbury, Ont. The strong feature of this new light is its durability combined with simplicity of construction. The light, which is entirely of steel assembled by the oxy-acetylene welding process, consists of but three parts and is made to withstand the roughest handling by unskilled labor without injury. One of the distinct advantages of the "Garrow" light is its adaptability for use in confined spaces, such as tunnels, mines, etc., without the slightest danger from escaping gas so commonly found in lights of this character. The "Garrow" light eliminates entirely the risk of gas being generated faster than the burner will consume it, by means of the patented by-pass chamber which conducts excess gas to the patented double burner and ignites it at the main flame. The Sudbury Construction and Machinery Company is equipped to manufacture this light in considerable quantities.

Operations of the Dominion Lime Company, Sherbrooke, Que.

THE Dominion Lime Company of Sherbrooke, Que., whose advertisement appears on page 287 of this issue, was established about thirty-five years ago and is well known throughout Canada and the Eastern States. Its business has increased from year to year, until the demand for their popular line has necessitated the enlargement of their plant. Heretofore the company used wood in the manufacture of lime, but a gas plant of the latest type has been recently installed which is producing a lime of very superior quality. This plant is the only one of its kind and probably the most up-to-date in Canada. Having doubled the capacity of the output the company are now in a position to meet the increasing demand for their lime.

The works are located about thirty miles from Sherbrooke, on the Maine Central Railroad, which is a convenient shipping point to places on this road as well as to Quebec Central, C. P. R. and G. T. R. points. The quarry from which the rock is produced, and which is in close proximity to the plant, is probably one of the most valuable in the country, and although it has been worked for the last thirty-five years, the supply is apparently inexhaustible. The quarry is equipped with the latest type of steel side-dump cars, drills and other apparatus. Cars are taken to the top of the kilns by cable incline and returned by gravity to the quarry floor. The new plant is built of steel and concrete throughout, making it absolutely fireproof. It consists of kilns fired by producer gas, engine, blower, etc. The foundations, upper and lower floors, are of concrete. On the firing floor coal is dumped into hoppers and fed to the producer. The oval shaped retort is nine feet long, eight feet wide, and twelve feet deep. Below the grate in the producer is a layer of ashes submerged in water, to prevent air entering from below. On either side of the producer are two sets of pipes, four in all, through which steam is injected at a pressure of 45 lbs. The steam carries the required amount of air necessary to create the gas, which latter passes into brick-lined steel flues, 48 ins. in diameter, running the entire length of the battery and kilns on both sides. The operation of the hopper below the kiln is governed by a lever from the firing floor. The lime is dropped into steel cars and distributed over the concrete cooling floor, 100 ft. x 100 ft. in size, ready for shipment. The steel stack connected with the producer is about one hundred feet in height and stands on a massive concrete foundation, without a guy line or support.

The plant is driven by steam power, generated by boilers embedded in concrete and brick. The fuel used is a high-grade bituminous coal. One of the products of the plant is broken rock, which is sold to contractors for concrete work and street improvement, also to machine companies for fluxing purposes. The company also owns an up-to-date saw-mill and plant for the manufacture of lime barrels. The officers of the firm are Messrs. William Farwell, President;

Thos. H. VanDyke, Vice-President; and Arthur F. Fraser, General Manager.

The "Abram" Cement Tools

The Abram Cement Tool Company, Windsor, Ont., manufacturers of the "wrist motion" line of cement finishing tools, have issued catalogue No. 3 which describes in detail the various labor-saving cement tools manufactured by the firm. To the sidewalk contractor who is anxious to secure time and lavor-saving devices it matters not whether his order be a mixer, wheelbarrow, scraper, grading plow, or the automatic sidewalk finishing tools, full satisfaction in the purchase is guaranteed. From the very beginning the firm have sold the Abram tools on the strength that one man can do more and better work with them than three men could do with ordinary tools. The reliability of this guarantee has been proved time and again by the appreciative letters received from satisfied customers and also from the fact that no purchaser has yet disputed the company's claim. The principle on which double action tools work is described in the catalogue under notice and the trowel, an illustration of which is here reproduced, is essentially practical, and possesses the qualities of simplicity and strength. This trowel, which has been patented by the firm, places the "Abram" tools in the forefront as practical, up-to-date time and labor-saving devices. Another essential of the contractor's equipment which the company are also placing on the market is the No. 112, 12-in. "Abram" adjustable handle plastering trowel. This trowel is claimed by the makers to be the best and highest class tool ever produced, possessing as it does the decided advantage of a vertical adjustment of the handle never disclosed before.

Portable Wagon Loaders

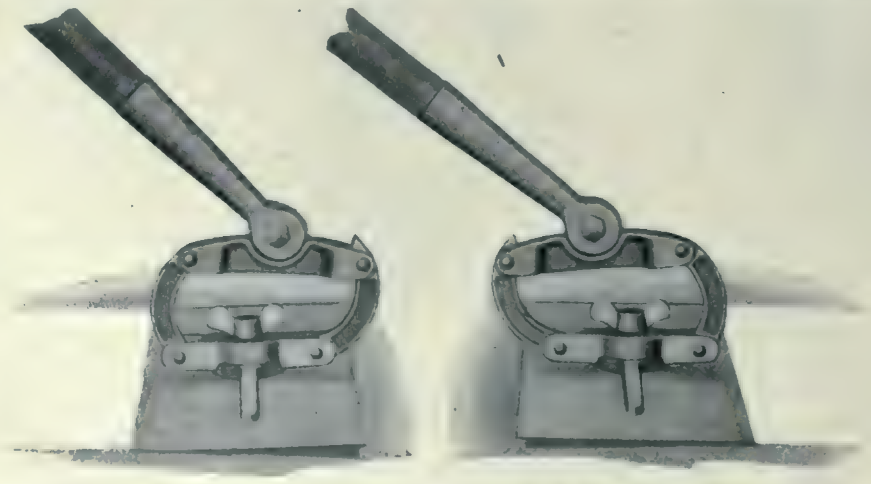
Handling sand and gravel in the old hand-shovel way is hard work, and it is expensive. The last few years have proved that it pays to economize in the loading of these materials, and to-day a light portable machine does the loading that formerly required ten men. The Portable Wagon Loader consists of a steel framework, mounted on wheels, which supports a strong bucket elevator in such a manner that the bucket-elevator can be pushed right into the base of a pile of loose material. The material is assisted to the buckets by the operator. In this way capacities of from 25 to 100 tons an hour can be obtained, depending upon the nature of the material and general conditions. The wagon loader will load a ton a minute or a 5-ton truck with coal in less than five minutes. The newest portable wagon loader completed recently by the Link-Belt Company, of Philadelphia and Chicago, is constructed along the lines as described above, with the addition of self-propelling mechanism for driving in either direction. It is fitted with a platform on which the operator rides, and a steering wheel to control the direction of travel. It can be used to handle coal, stone gravel, sand, cement rock and clinker. The flight conveyor at the end feeds the material with regularity to the buckets and usually takes the place of a shoveller at this end. The portable wagon and truck loaders are described in Link-Belt Company Booklet No. 170.

At Fort William, Ont., building permits for the first four months of the present year totalled close to $600,000. While these figures are much below those of the same period twelve months ago, the number of permits is far in excess of last year.

A survey preliminary to the construction of a sewage system for Redcliffe, Alta., at an estimated cost of $250,000, was completed recently by Mr. W. J. Francis, engineer, of Montreal. Plans are expected to be completed in a few days, on receipt of which the construction of the trunk and lateral sewers will proceed at once and the scheme will probably be completed before the fall.

The Pacific Lock Joint Pipe Company, contractors for reinforced concrete pipe for the flow line of the Sooke Lake waterworks system, have laid the first length of pipe and are now in a position to deliver the stipulated daily quantity of pipe lengths. Between Cooper's Cove and Humpback Reservoir, work on the concrete trestles is proceeding rapidly preparatory to the pipe laying.

The extensions to Fort William's municipally-owned street railway were commenced a few days ago, and during the summer there will be quite a large programme of construction work carried on. The first work to be undertaken will be the construction of the new belt line along North Syndicate and Pacific avenues, Victoria avenue west to Franklin, and Franklin street south to Walsh street. The street railway extension to the Island across the Bascule lift bridge is practically completed, and all that remains to be done are a few connections which will be completed before the end of May.



The "Abram" wrist-motion double action sidewalk finishing trowel.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.

HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 **May 20, 1914** **No. 20**

Principal Contents

Professional Bids ... 637
Engineering Topics in the Old Land ... 638-9
Special London, Eng., Correspondence
The Weston, Ont., Sewerage System ... 639
Practical Considerations in Concrete Arch Design ... 640-5
By E. G. Kaufmann
Canadian Constructional Centres, Part II. ... 645-53
Biographical Sketch, W. Hollingworth ... 653
The Artistic Possibilities of Bonds and Mortars in Brickwork, Part 1. ... 654-62
A Symposium on Heating and Ventilation and Some Mechanical Errors of Installation ... 663-4
By Thomas Morrine
The Value of Cost Data in Highway Engineering ... 664-5
By Major Crosby
Interesting Application of Cableways ... 665-6
Constructional News ... 666-8

"The Artistic Possibilities of Bonds and Mortars in Brickwork," the first part of which is published in this issue, is an essay on design in patterns for brickwork, with special reference to bond and the use of mortar. The various bonds in use are classified and illustrated by diagrams and the methods of using bond units in pattern are described and illustrated. The essay describes the structural uses of mortar, the artistic effects which can be produced, the various kinds of mortar joints, and the methods of using colored mortar. The concluding portion, Part II, will be published in our next issue.

Professional Bids

WE have received a copy of a circular letter which has been sent by the Council of the Institution of Civil Engineers of England to the members of that body. "The Council," runs the circular, "have had their attention drawn for some time past to a practice which exists among Local Authorities, of inviting by advertisement engineers to submit in competition with others their terms for preparing plans and proposals for certain engineering schemes, accompanied then or at a later stage by estimates of the cost of the works proposed. In the opinion of the Council such a proceeding is very undesirable in the best interests of the Public Authorities themselves and is derogatory to the engineering profession. The Council desire to express emphatically the repugnance with which they regard the practice in question. They have every confidence that the members of the Institution will support them by declining to respond in any way to such advertisements as those alluded to."

We seem to have heard of protests of a similar nature having been made by contractors against the system of competitive tendering. Contractors have "to submit in competition with others their terms . . . . . for certain engineering schemes," and such terms have to be "accompanied. . . . . . by estimates of the cost of the work prepared." There is no recompense for the labour involved, no surety that work will follow even in regard to one among the number estimating; and when the hardship entailed has been put before the engineering profession no hand of sympathy has been extended. Contractors are expected to regard as a favour the permission to prepare rough plans, to take out quantities, to pay for the services of a staff of practical estimators, to undertake lengthy journeys, and to run an enquiry bureau. But when the engineer is asked to occupy the position which has been forced upon the contractor indignation is loudly voiced and "repugnance expressed."

That the practice referred to by the Council of the Institution of Civil Engineers is a reprehensible one admits of no doubt. Competition may be carried beyond the limits of endurance, and local authorities are certainly not justified in inviting tenders for professional services. There are recognised scales of fees and commissions in every profession, and these should be paid (by public bodies above all) to the uttermost farthing. It is unfortunate that engineers should be thus hoist by their own petard, and our sympathy would be keener had engineers ever exhibited the least sympathy with the unfortunate contractor. We fear much (and we regret to have to say it) that the repugnance expressed by the Council needs somewhat in the way of qualification. It is the old, old question of the top dogs over again. So long as the element of competition is excluded, the big jobs go to the big men. The small man, no matter what his attainments, stands no chance at all. He is clean out of the running. But directly tenders are invited, he will be very much in the running, for it will pay him to cut the price even below cost. The first rung of the ladder is the most difficult to negotiate; the other rungs may be mounted with almost mechanical precision. Judging by what does happen, the confidence of the Council in the fact that "members of the Institution will support them by declining to respond in any way to such advertisements as those alluded to" is singularly misplaced. The younger members, the members who are awaiting their first call, who are preparing for the first run, are more than ready to tumble over each other in their eagerness for the butter which will assist the swallowing of the dry bread of life. It is regrettable, but life is made up of hard and distasteful facts, and the members of the Council of the Institution—whose bread is buttered on both sides and on every edge—must be prepared to face at least one of them. May that fellow feeling which is said to make one wondrous kind lead the engineering profession (or at least its shining lights) to deal more mercifully with the humble but necessary contractor.

Engineering Topics in the Old Land

Concerning Criticism—Tampering with Tenders Once Received—A Side-Light on Architects' Estimates — Recognition of Professional Status

By the London, Eng. Correspondent of the Contract Record

THE Contract Record is so full, week by week, of "meat"—and by meat is meant good, strong satisfying pabulum of the mental kind—that the temptation to criticise (or at least to comment upon) what is presented becomes almost irresistible. There are papers and enough published which offer no inducement whatsoever of that kind. They have neither initiation nor originality; their editorials are colourless and non-committal; and if they have any opinions on anything they must hand them over to the sacred custody of the advertisement manager, for the readers hear nothing of them. A good editorial must provoke both comment and criticism, and its value may be pretty accurately gauged from its success in provocation, although it must be remembered that criticism does not necessarily imply either censure or unfavourable judgment. "Critic" is one of those words that is unfortunately losing its original meaning, and any caviller and fault-finder now arrogates it to himself. The writer would therefore prefer his "criticism" of certain articles which have appeared in the Record to be regarded merely in the light of a commentary.

"Unsavoury Contract Procedure"

In an article under this heading the action of the Bermondsey Borough Council, in allowing the amount of a tender to be altered after consideration of the whole of the tenders received, was condemned. As was rightly said, "it is an outrage upon those who play the game in good faith to allow any addition or subtraction once the hands have been shown." Fortunately, the instance is an isolated one, and in the usual course of things the next lowest tender would have been considered for acceptance. The expression "once the hands have been shown" is an exceptionally happy one in this connection, for competitive tendering partakes largely of the nature of a gamble. In a game such as "banker" the highest card turned up takes the bank; in the game of "tender" the lowest stands to receive the cheques (during the progress of the works); and neither game would be any longer possible were the players allowed to plead that they had, through inadvertence, shown the wrong card. The hands once proclaimed, there can be no question of a revoke. In certain games a player is permitted to "brag" or "bluff" as he pleases, but again, his hand once shown, he must abide by the count. The unfortunate fact in the game of tendering is that the players are not always present to lay their cards on the table. Contractors should be given the opportunity to attend, either personally or by deputy, and as the tenders are opened the amounts should be read out for their benefit. With the seals unbroken until the formal opening, no suspicion of unfair treatment could enter. Such an arrangement would be satisfactory to all parties concerned, and it should be clearly understood as a preliminary that the lowest tender (or preferably the lowest but one) would be accepted; subject to confirmation by the tenderer and the carrying out of the usual formalities. No alteration in an amount should be made on any pretext whatsoever, the "hands once shown."

Architects' Estimates

That architects' estimates are invariably low is indisputable, and the most potent factor in bringing about such an undesirable state of things is the ignorance of the architect. There was a time when architects actually superintended the building of the structures they designed, when they did not disdain to act as clerk of works. Sir Christopher Wren "clerked" the erection of St. Paul's Cathedral, and there is no record of his having dispatched a youth at more or less irregular intervals "just to see how things were going on." The curriculum of an architect's education includes building construction, but it does not include building, and no man should be regarded as an architect unless he has been in actual contact with building operations. The mere ordering of materials is an education in itself, and not five per cent. of those practising as architects could perform such a duty on a job of any size; and when it comes to structural supervision and the directing of mechanics not one in a thousand could emerge with credit from the ordeal. Plans are prepared and specifications written without regard for either the one or the other of these matters, and money is thrown away wholesale on scantlings that cut to waste, on special mouldings that are frequently quite inferior to those to be obtained from stock, on materials that have to be fetched from far afield when they could be supplied locally equally as well, on "purpose made" goods, and on a hundred and one other crank requirements and petty exactions. In the preliminary estimate of the cost of the projected work, these items are not considered, primarily for the reason that only a sketch plan or two has been prepared and not a word of the specification committed to paper. The client is quoted quite a fallacious figure and on this he gives the order to go ahead. As the plans and documents grow, the architect begins to realize that he has cut it "just a bit fine," and he sets about preparing his client for the shock, trusting however to luck (in the way of a low tender or two) to scrape through. But the day of reckoning arrives, and it is found that the building will cost from 20 to 30 per cent. more than the amount of the preliminary estimate, and the lowest man is taken into a kind of consultation and all manner of little economies are introduced and not a few glowing inducements held out to him if he will meet the architect in a small matter or two. Frequently, however, the plans have to be rigorously cut down and fresh estimates obtained, a course which inflicts great hardship upon the competing firms. There are, of course, many other reasons why architects' estimates are low, but they have been already dealt with in the editorial of April 1, in which issue also appeared an excellent article by Mr. Allen Hazen on the same matter.

Professional Status

It is refreshing to read that "the British Columbia members of the Canadian Society of Civil Engineers have recently shown considerable activity in endeavouring to get the status of the Engineer recognized by the Provincial Government," but the question that comes naturally to one's mind is: Why the British Columbia members only: why not the members of the whole society? And—had it not been for recent events in Ulster—one might have asked, why only one Provincial Government: why not all the Provincial Governments in the Dominion? As things are, the Englishman can no longer throw stones! Due professional status granted to engineers by the Government of British Columbia, the wedge will have been inserted for a similar concession in other Provinces; but surely the hands of the petitioners would have been strengthened if the whole forces of the Canadian Society of Civil Engineers had been concentrated in the attack.

Now, as to the definition of an engineer. That asked for in the new Water Act, that "Engineer means an Engineer of the Water District, who shall be a Civil Engineer who is a member of the Canadian Society of Civil Engineers, or a member of the Institution of Civil Engineers of Great Britain or of Ireland, or a member of a Civil Engineering society of equal rank in the British Empire or any foreign country," is good as far as it goes, and is perhaps the best that could be devised, but the saving clause added at the request of the Minister of Lands "gives the whole show away." This clause runs as follows: "But the foregoing definition shall not limit the power of the Lieutenant-Governor-in-Council or the Minister to appoint to any position created under this Act, any person who is in his opinion competent to fill such position," and the very thing that the deputation pointed out as objectionable in the Ditches and Water Courses Act, 1907, viz., that there was "nothing to prevent a Municipal Council from appointing a gardener, blacksmith or carpenter to carry out the duties of the Act as Engineer" applies in the new Act with perhaps equal force. It may, of course, be argued that "the Lieutenant-Governor-in-Council or the Minister" would never be guilty of making such ridiculous appointments, but nepotism and the influence brought to bear by members of the opposite sex may result in appointments equally inimical to the interests of the engineering profession. A carpenter would make a much better engineer possibly than an English college-bred youth whose knowledge of things in general was derived largely from the Latin and Greek authors, while even a blacksmith would know something about ironwork (chimney bars for example) and a gardener might prepare an excellent town plan on garden city lines. "Any person" is capable of wide interpretation, and the opinion of a Lieutenant-Governor-in-Council or a Minister (it may be submitted with all due respect) does not necessarily mean much. Still, the Western members are "to be congratulated upon the success of their efforts," and they certainly deserve well of their fellows. May the good work spread, until not only the engineers of the whole Dominion but of the Mother Country as well obtain Government recognition of professional status.

The Weston, Ont., Sewerage System

THE new sewerage and sewage disposal works at Weston, Ont., were officially opened on the morning of May 9. The sewerage work was constructed under contract by Messrs. Campbell, Lattimore & McAllister, of Toronto, while Mr. F. F. Fry was the contractor for the purification plant. The engineers for the work were Messrs. Aird Murray & Lowes, Toronto. The cost of installing the domestic and surface water sewerage was $111,511, and of putting in sewage purification works, $23,134, a total of $134,645.

The surface water from roadways is conveyed by sewers apart from the domestic flow direct to the River Humber, while the domestic sewage is conveyed by a separate system to a location situated on the banks of the river, where it undergoes a series of treatment processes, which produce an odorless, clear effluent.

The sewers are so constructed and laid out with reference to line and gradient, that perfect control is established by which any section of the system can be examined, cleaned, or any chokage removed without in the future disturbing the road surfaces. Manholes at all changes of grade and direction allow an inspector to look through any section of sewer, and if necessary clean out any section with sewer-cleansing rods. For the small sizes vitrified pipes with cement joints are used and for the large sizes, reinforced concrete pipes made on the trench side have proved very efficient and economical.

The purification works consist of three distinct processes, viz:—The arresting of the solids contained in the sewage; the oxidation of the sewage liquid by passing it through percolating filters; final treatment of the liquid from the filters by humus arresting tanks and subsoil irrigation on land.

The solids are separated from the sewage by aid of gravity in tanks, the arrested sludge gravitating to separate decomposing tanks where it is stored for a sufficient period to allow of thorough rotting. The rotted sludge which is odorless is conveyed to an open sludge drying bed, where it readily becomes firm enough to be handled and used as a manure.

The oxidation of the liquid sewage takes place in two filter beds, where the method of distribution and oxidation is automatic and extremely efficient, the liquid sewage being sprayed over the whole surface of the bed in even quantities.

An instance of the enterprising development of Western Canada by the railroads is provided in the announcement that seven hundred miles of standard gauge lines will be built in the province of Alberta this year, as compared with six hundred miles in 1913. More than $11,000,000 is available for construction work in Alberta on railroads guaranteed by the government. This sum includes $6,500,000 which has been deposited to the credit of the Alberta & Great Waterways Railroad agreement. This line will extend from Edmonton to Fort McMurray, 350 miles. The construction to be undertaken this year will include the Peace River branch of the Canadian Northern.

Practical Considerations in Concrete Arch Design

Specially contributed by E. G. Kaufmann*

THE last few years have brought with them a very marked development in the form of masonry arch bridges. Our knowledge of theory and its practical application has made such strides, in so short a time, that in order to be able to make good, up-to-date designs it is necessary for the engineer to remain thoroughly abreast of the times.

The idea of stone bridges is ancient. The Romans used them extensively, but they seldom exceeded spans of eighty feet. A bridge built of stone is a monumental structure, combining beauty with durability. London Bridge, built of granite, is an example of the most stable and lasting structures.

Concrete bridges, however, are modern. Comparatively few were built more than thirty years ago. Although concrete, as it is used at present, is not as durable as good stone, its wearing qualities are such as to create what may well be termed "a permanent structure." In appearance it falls well into line with modern architectural principles, while its cost is far less than that of stone.

The development of the use of reinforced concrete naturally suggested its application to arch design. The economy of reinforced over plain concrete for arches is not very marked, for the stresses in an arch are chiefly compressive, and concrete is better adapted to take such stress than steel. The introduction of steel to take compression is not an economy. However, the introduction of steel makes it possible for tension to exist in parts of the arch ring, thus making it permissible for the thrust line to depart from the middle third. Morover, reinforced concrete is a more reliable material and is better suited to resist certain unforeseen or uncertain stresses—such, for example, as are due to temperature and construction distortions.

The hingeless, or fixed arch, with which this paper will deal chiefly, is the oldest form in use. The common forms of this type are the Melan and the Monier, while there are many modifications of these. The Monier arch employs mesh reinforcement close to the extrados and intrados. In the Melan arch heavy structural ribs are put into place and filled in with concrete. The main advantage of this form is that the steel ribs are capable of supporting the entire ring before the concrete has set. In this country most of the designs employ rod reinforcement in almost any form.

Hinges are applicable in arches built of almost any material. The advantage is that, as the thrust line must pass through the hinges, the arch becomes determinate and presents a more reliable and simple design; moreover, a hinged arch is less liable to failure due to settling of the abutments, and the large excentricities of the temperature thrust are avoided.

It is frequently asserted that hinged arches are more economical than fixed arches. This is questionable, as the cost of the hinges is very considerable, and because whatever small saving there is in concrete cannot properly be allowed for at much above the cost of the materials, the cost of forms being approximately the same for the two types. The appearance of the hinged arch is, in the writer's opinion, in its disfavor. To the trained eye, at least, the increase in depth at the abutments of the fixed arch is pleasing, as this is the point of maximum shear. In the three-hinged arch, on the other hand, the ring is smallest at the crown and abutments, as there it receives thrust only. The moment is maximum at the quarter points, and the bulge which must exist to resist this is unsightly.

Hinges, usually of stone, are frequently placed in the crown of fixed arches during construction, being grouted in after the entire arch ring has set. This is a very good safeguard against cracks due to construction deformations, particularly in arches of long span.

The most modern arch of either type is built of ribbed rings instead of building the arch ring of the entire width of the bridge. This produces a lighter construction and is more economical. Ribbed rings, of course, necessitate open spandrels.

Before deciding upon the kind of arch to be used it is important to study existing conditions. The item of cost will have considerable weight in this connection, and it will usually pay to prepare several preliminary estimates. Local conditions play an important part, and frequently the cheapest bridge will not be the most economical.

If rock foundations are available, the engineer is free to choose. In this case the writer would recommend the fixed type, on the grounds of economy, appearance, and as it is less liable to vibrations. In very flat arches, however, the eccentricity of the crown thrust due to temperature may be so great as to make it advisable to introduce a hinge.

If, on the other hand, the bridge must be founded upon earth, the problem becomes less reliable. One of the fundamental assumptions of all theory is that the abutments are immovable, and any settling may produce stresses which cannot even be guessed at. It is true that stresses due to abutment displacements can be computed if those displacements are known, but this is usually limited to construction and elastic distortions. Settling of foundations is entirely unknown and accidental. To make the structure strong enough to resist stresses due to this cause would greatly increase the cost, whereas some other device would produce superior results more economically. On poor soil, where settlement is probable, a concrete arch should not be attempted unless it is considered that piles would furnish ample rigidity. In case it is necessary to found an arch of long span and low rise upon earth, even though reasonably good, a three-hinged arch would undoubtedly be safer, as it can lend itself to slight motions. If a hinged arch is to be used it will be better in the majority of cases, to use ribbed rings. It is always advisable for each hinge to be continuous, and hinges of the length required for a barrel arch are not only costly but difficult to handle. In this connection it should be remembered that the ribs should be well braced together.

The form of the spandrels is also to be decided upon. For railway bridges, filled spandrels are usually in favor. A barrel arch with the fill carried across it adds to the uniformity of construction, besides being easier to build and sometimes cheaper than an open spandrel bridge. Moreover, the solid walls and filling are likely to produce an independent arch action which will assist in supporting them. It is probable that many arches of inadequate design owe their stability to this cause. Furthermore, the filling tends to distribute the loads and absorb shock. For these reasons it will often be of advantage to build short railway bridges with solid filling. However, the arch action of the filling cannot be relied upon, failing altogether in long spans and merely adding its weight to the load on the bridge.

---

* **Engineer, Masonry Design Department, Messrs. Mackenzie, Mann & Company, Limited, Toronto.**

Another assumption of all theory is that the arch ring is free to act as an elastic body. It is evident that filled spandrels seriously curtail this freedom of action. In fact, this hindrance is so marked, that any refinement in the design is nullified, and the stresses computed may differ greatly from those actually existing. For a long or flat arch, therefore, filled spandrels should not be considered. The floor system should be provided with expansion joints in order to prevent unnecessary strains in the ring.

A thoroughly scientific analysis should not be neglected. The design of a concrete arch is one of the most delicate operations which an engineer is called upon to perform. Small differences in the shape or form of the arch produce very great differences in its strength. Surely it cannot be an economy to slight the design of a monumental structure, which is intended to stand for ages, in order to save a few hours, or days, of the engineer's time. The practice of using empirical formulae, and constructing an arch which "looks like" another that has stood, cannot be too strongly condemned. When this is done because of the engineer's lack of knowledge or familiarity with theory, it would appear that strict government control were needed. At first glance the process may appear formidable, but really it is not so. When familiar with the details the design becomes simple, though of course somewhat laborious. An analysis can easily be carried through in one day, or at most two days.

In the design of an arch, after the type, loading, floor system and other details have been decided upon, the first consideration should be the shape of the ring. The importance of a good shape, in economic design, cannot be overestimated.

In this connection it will be well to point out some of the requirements of good design. The stresses in an arch are inherently compressive. Although tension may exist, it is far better to reserve it for temperature and unforeseen effects. The ratio of moduli of elasticity of steel to concrete is commonly assumed to be 15. Now steel costs considerably more than fifteen times its volume of concrete; hence it is more economical to make the thickness of the ring adequate to keep the chief stresses compressive than to permit tension and introduce a great deal of steel. Frequently the ring is so designed that the dead and live load stresses are all compressive, and enough steel is used to take care of the tension caused by temperature. As long as the thrust line remain in the middle third of the ring, no tension will exist. In view of this fact the thrust line should be kept as close to the centre line of the ring as possible. With uniform or stationary loading these two lines can easily be made to coincide fairly closely. There are two ways to do this: one is to fit the thrust line to the centre line by means of a judicious distribution of the dead load. Whenever the shape of the intrados is fixed by architectural or other reasons it will be of advantage to proceed in such manner.

In general, it is better to fit the centre line to the line of thrust as determined by trial. The following will serve as a guide and lessen the labor of approximation.

In Fig. 1 consider the parabolic arch 0-4-10, in which the horizontal projections of the divisions are equal. The line M-N is vertical, and P is any pole. Successive rays are drawn from P to 0', 1', 2', etc., parallel respectively to the tangents at points 0, 1, 2, etc., of the arch. It can be seen that the intercepts on the force line M-N are all equal. In other words, if the total load on the bridge is uniform from end to end, the thrust line will be parabolic. This can never occur, because the weight of the ring and spandrels is always greater at the springing than at the crown.

Proceeding in the same way with a semi-circular arch, it can be shown that the load nearest the springing must be infinitely great, which is of course impossible. As the arch becomes flatter the parabola approaches the circle, but the thrust line can never exactly coincide with either one. It will generally lie about half way between the two. The radius of the circle passing through the springing and crown points can be found from:

$$R = \frac{L^2}{8h} + \frac{h}{2}$$

where L = span of intrados and h = rise of intrados. The parabola for the same points can be drawn by means of the following formulae for co-ordinates:

$$x = \left\{\frac{L}{2}\right\} n \qquad y = h\,(2n - n^2)$$

where L = span of intrados, h = rise of intrados, n = any fraction or decimal less than one, x and y are co-ordinates measured from the springing points as an origin. The circle and parabola having been drawn, as in Fig. 2, a three-centred curve can be drawn midway between them, as a trial intrados, for open spandrel arches. For filled spandrel arches, however, the intrados will be somewhat nearer to the circle. This process will give a fair approximation of the correct shape, but must be investigated, and revised if necessary. It can be checked by drawing the thrust line for dead or dead and half live load. For this purpose the live load must be reduced to an equivalent uniform load. The method is described below.

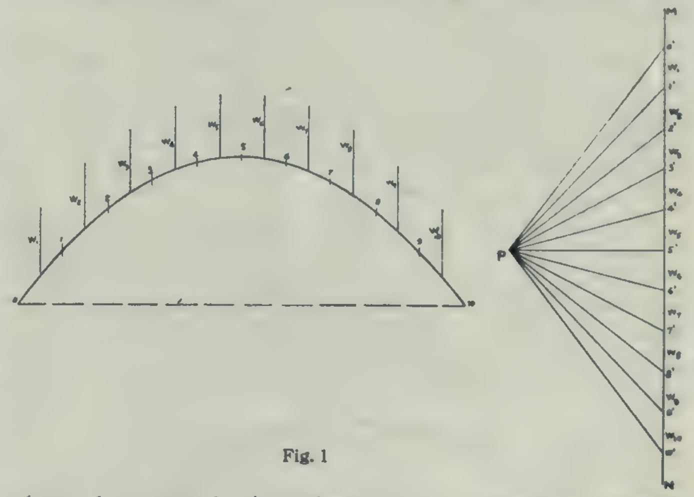


Fig. 1

The dead load alone is frequently used for this purpose, but it is a little more accurate to use the load for average working conditions. Such conditions will evidently be obtained when half of the live load cover the bridge from end to end.

The thrust line for unsymmetric loading will, of course, depart from the centre line, but generally it will be as close as it is possible to make it.

When the shape of the arch has been found correct, and after an approximate determination of the stresses, which makes possible an intelligent assumption for the thickness of the ring, the rigid analysis can be commenced.

The older method of applying the elastic theory by dividing the ring into sections of constant ds/I is probably the shortest when only one or two assumptions of loading are made. But the stresses by this process are neither maximum nor minimum in any section. The greatest stresses cannot be found by using either the whole or half length of the bridge loaded. They can be approximated, by this analysis, only after a great many trials, and as the entire analysis must be carried through for each trial, the labor is very great. By the use of influence lines the only preliminary approximations are the shape and thickness of the arch ring. Almost the entire analysis can be carried through before any loads are applied, and any desired loading can then be investigated with very little labor. The influence lines indicate the exact position of the live load necessary to produce maximum and minimum stresses.

David A. Molitor, in the last chapter of his "Kinetic Theory of Engineering Structures" (McGraw-Hill Book Company) gives a very lucid and satisfactory explanation of such an analysis by the method of virtual work. He carries through a complete sample analysis of a symmetric and an unsymmetric arch. By this method the resultant polygon need not be found, the stresses being found directly. However, as it entails very little extra work, it is well to construct a resultant polygon for unsymmetric loading, as it indicates conditions throughout the ring at a glance, and affords some valuable checks. This method appeals very strongly to the writer.

Another method which employs influence lines was explained by A. C. Janni in the Journal of the Western Society of Engineers—May, 1913. This is the method of the "Ellipse of Elasticity." Like the other, it admits of the investigation of any loading, but for highway bridges, where the live load is small compared to the dead load, and can be considered uniformly distributed, the preliminary analysis will suffice, saving the labor of the final investigation.

These two exact methods can be carried through with such ease and celerity that it does not seem worth while to employ approximate methods. The most prejudicial loadings are fully investigated, and consequently they can be regarded with full confidence, provided, of course, that the foundations be adequate and that the construction be carried on in a workmanlike manner.

The effect of temperature has frequently been omitted in arch design. The fact that such arches have not failed is no excuse for omitting it in designs. Their stability is probably largely due to the effect of the spandrel filling, as mentioned above. Ira O. Baker, in his "Masonry Construction," gives the results of some tests of the range of internal temperatures in concrete, which showed that while the temperature of the concrete did not closely follow the atmospheric changes, it still varied by about 45 deg. Fahrenheit during the year. Such a range of temperature would produce stresses, greatest in flat arches, which should not be neglected. A range of 25 deg. up and 25 deg. down will usually be sufficient. As the arch will not be built in the coldest weather, and as heat is generated in the concrete due to setting, a rise of temperature need not always be considered, although the work of doing so is small.

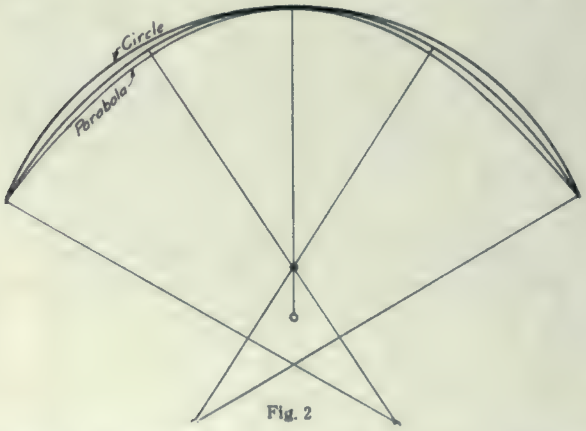
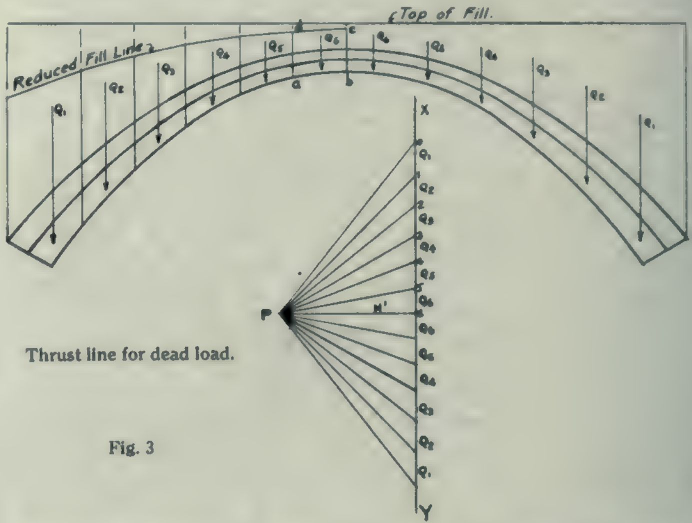


Fig. 2

The shrinkage of the concrete due to setting, and the shortening of the arch axis due to striking of falsework, produce stresses similar to those produced by a fall of temperature. These stresses can therefore be allowed for by assuming a greater fall of temperature.

Rib shortening due to axial thrust produces stresses opposite to those due to a fall of temperature. For arches of good rise they are small, and, being on the safe side, may be neglected. The time saved by neglecting any of these effects is so small that it is hardly worth while to omit any of them.

As was mentioned above, the actual stresses in a filled spandrel arch are so far from those found in any analysis that the time spent in such a design is, as a general rule, practically wasted; however, when the loads are heavy, the exact design should always be used, as it will give far closer results than any approximate method. For flat or long span arches filled spandrels should not be used if they can possibly be avoided; if they must be used an exact analysis is important.



Thrust line for dead load.

Fig. 3

The following approximate method is valuable for preliminary estimates. It may be used for highway bridges of small span and good rise, in the absence of any other, although it is always advisable to use a more rigid analysis if possible.

This design is based upon the assumption that the most favorable thrust line is the most probable one, and that if one thrust line can be drawn which does not depart from the middle third of the arch ring, then the true one will surely lie within the middle third. This assumption has never been proved infallible, but in all likelihood it is near the truth. Voussoir arches have frequently been designed upon this assumption, with success.

In making use of this principle, the thrust line for any case of loading should always remain within the middle third. The addition of temperature stresses will then introduce tension and enough steel must be added to fully resist it. ½ to 1 per cent. of steel should be added, at least, near both the intrados and extrados.

The shape of the intrados is first approximated, as described above. Then by the use of any empirical formula a trial crown thickness is found. The following formula, from Trautwine, will answer this purpose: $d = \frac{1}{4}\sqrt{R + L} + 0.2$ where d = depth of crown; R = radius of intrados at crown; and L = span of intrados, all in feet.

The extrados is then drawn, making the arch ring at the quarter points 1¼ to 1 1/3 times the depth at the crown, and at the springing 1½ to 2 times the crown depth. Draw the axis midway between the two, and divide into any number of parts, preferably equal, by vertical lines as shown in Fig. 3. A single rib one foot wide will be considered, so that the area of each section of the arch ring in square feet will be equal to its volume in cubic feet. Draw a curve which would represent the height of fill if it were solid concrete instead of earth, as shown by the "Reduced Fill Line" on

Fig. 3. The weight of dead load at any point is then the area of the section, between the intrados and the reduced fill line, multiplied by 150 lb. To illustrate, the dead load at Q_6 = (area a-b-c-d) x 150 lb., and acts through the centre of gravity of a-b-c-d. In this way all the dead loads are computed, and their lines of action drawn. The horizontal pressure of the earth may be neglected. These loads are laid off to scale on the force line X-Y. The horizontal thrust at the crown is computed from the following formula:

$$H = \frac{Wx}{h^1}$$, where H = crown thrust; W = sum of loads $Q_1 + Q_2 + \ldots + Q_6$.

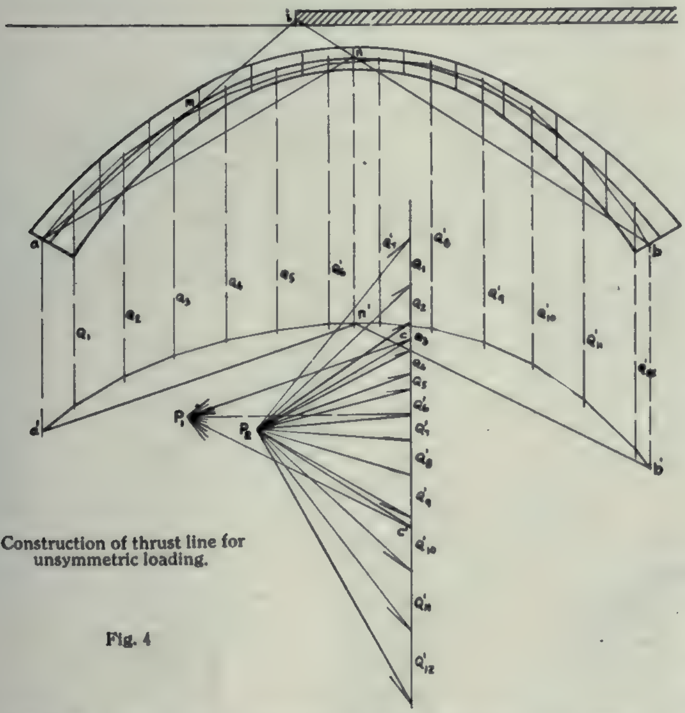
x = distance of centre of gravity of these loads from the springing;

and h^1 = rise of axis.

H is laid off horizontally, to the same scale, from the centre division of X-Y to determine the pole P.

The rays P-0, P-1, P-2, etc., are drawn. Now the thrust line can be drawn by commencing at the crown point of the axis, drawing a horizontal line to intersect Q_6. From this intersection another line, parallel to P-5, is drawn to intersect Q_5; from this point a line parallel to P-4 is drawn to intersect Q_4, and so on. This thrust line will pass through the axis at the springing. If it coincide closely with the axis, the shape of the intrados is accepted; if not, the shape must be revised and the operation repeated. The normal thrust on any section can be scaled off, being the component of the corresponding ray, parallel to the tangent to the axis at that point.

The thrust line for unsymmetric loading is now proceeded with. Referring to Fig. 4, the live load will cover that part of the span between the right end and the point "i." "i" is found as the intersection of a-m and b-n, where a and b are at the edges of the middle third; m is the quarter point of the axis; and n is ⅛d above the axis; all as shown. This position of the load will give nearly maximum stresses in the springing and quarter points. The loads Q_1 to Q_5 are dead loads. Compute Q'_6, Q'_7, Q'_8, etc., and lay them all off to scale on the force line, as shown. Assume the trial pole P_1 and draw the trial thrust line a'-n'-b', where a', n', and b' are vertically in line with a, n, and b. The thrust line is kept out of the drawing in this case in order to avoid confusion of lines. Draw a'-n', and P_1-c parallel to it, to find c. Then draw b'-n', and P_1-c' parallel to it to find c'. Now draw c-P_2 parallel to a-n, and c'-P_2 parallel to b-n, to find the true pole P_2. With the force line already drawn, and the pole P_2, construct the true thrust line, commencing at a; it will pass through n and b. If this line lie everywhere within the middle third of the ring but approach closely to the edge in two points, then the thickness of the arch is accepted, and the stresses are computed. If the thrust line pass outside of the middle third in two places, then the arch ring must be made deeper. However, if the thrust line pass out of the middle third in one point only and be far inside at every other point, then the point n should be moved a little up or down and the operation repeated.



Construction of thrust line for unsymmetric loading.

Fig. 4

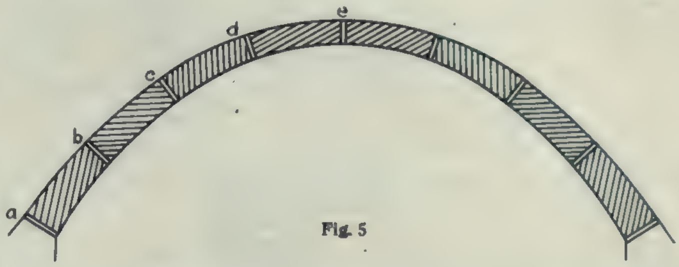


Fig. 5

If this thrust line be acceptable, then the normal thrust and its eccentricity for any section can be scaled. The stresses in any section can then be computed by means of Navier's formula:

(1) $$f = \frac{N}{d}\left\{1 \pm \frac{6e}{d}\right\}$$, where: f = stress in lbs. per sq. in.,
e = eccentricity in feet,
d = depth of section in feet,
N = normal thrust in lbs.

These stresses will all be either zero or negative, as no tension will exist.

In a similar manner the thrust line and stresses for a symmetric loading, in which the live load covers the middle of the bridge, from quarter point to quarter point, can be found. This will procure nearly maximum stresses in the crown section.

Mr. Molitor showed that the only critical points are the springing, the crown, and a point near the quarter point. In this approximate method it will be near enough to consider the springing, crown and quarter points, and only these need be computed.

To the stresses thus found should be added those due to a change of temperature. In the Proceedings of the American Society of Civil Engineers for January, 1914, page 147, Mr. L. J. Mensch has deduced the following approximate formulae for temperature stresses, which can be applied to arches of this character:

(2) Stress in crown section = ± 1,540 d/h.
(3) Stress in springing section = ± 1,256 d/h.
where: d = thickness of arch at crown;
and h = rise of arch.

These stresses are the same for any span and are figured for a variation of 50 deg.

At the quarter points the temperature stresses are nearly zero. The stresses found by means of equations (2) and (3) should be both added and subtracted from those found for the corresponding sections by means of equation (1). Whenever tension be produced by the application of the temperature stresses, it must be cared for by a sufficient amount of steel. If necessary the arch ring should be made thicker in order to reduce the live load stresses. Although this will increase the temperature stress, it will decrease the total stress.

The above method, with the exception of the temperature

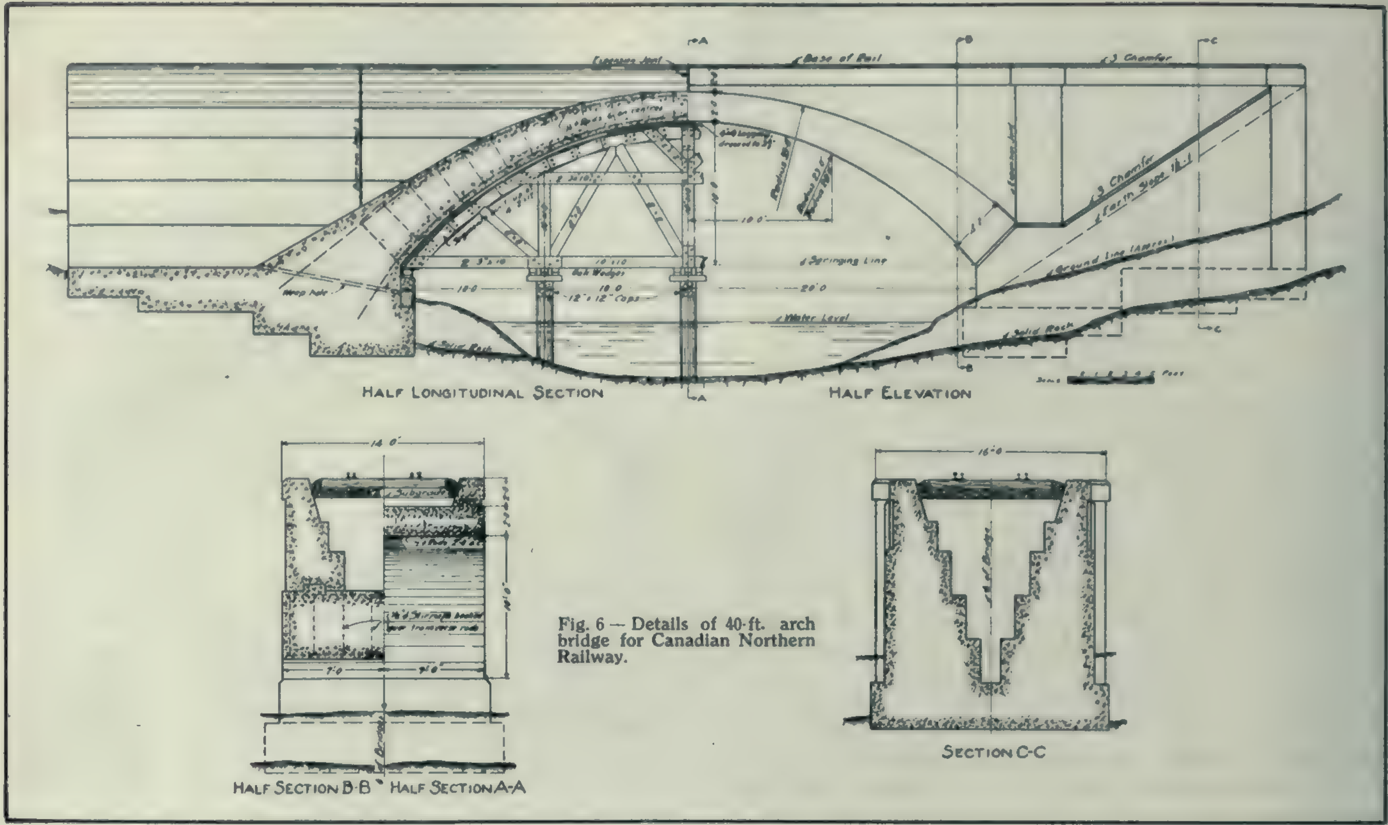


Fig. 6 — Details of 40-ft. arch bridge for Canadian Northern Railway.

allowance, is employed by Mr. Molitor as a preliminary investigation.

It must be borne in mind that an analysis by this method is merely an approximation and should never be used as a final analysis of an arch of low rise, long span, or heavy loading.

The reliability of all theory depends largely upon the stability of the abutments or piers. Many failures have resulted from the unscientific design of these important features. It should be remembered that the abutments must be designed not only to present sufficient bearing for the vertical pressure but also to horizontal thrust.

Much also depends upon the methods of construction. The centering must be made firm enough that it will not settle when the concrete is placed upon it, in order that the arch may have the shape it was designed for and that the concrete will not crack before it has firmly set. The centering is sure to settle to some extent, and consequently the manner of placing the concrete should be given ample attention.

If the arch be small enough that the entire ring can be poured in a single day, this difficulty is easily overcome, for then the entire dead load is applied to the centering, and the arch keyed, before the concrete has fully set.

If, however, the placing of the concrete be begun at the abutments and be carried toward the crown on successive days, then each day's work will produce a greater degree of deflection in the centres, thus introducing serious construction stresses into the concrete at the springing, which has already set. This effect can be largely overcome by pouring the concrete in voussiors, leaving spaces as at a, b, c, etc., in Fig. 5. Then these intervening spaces are all keyed at the same time.

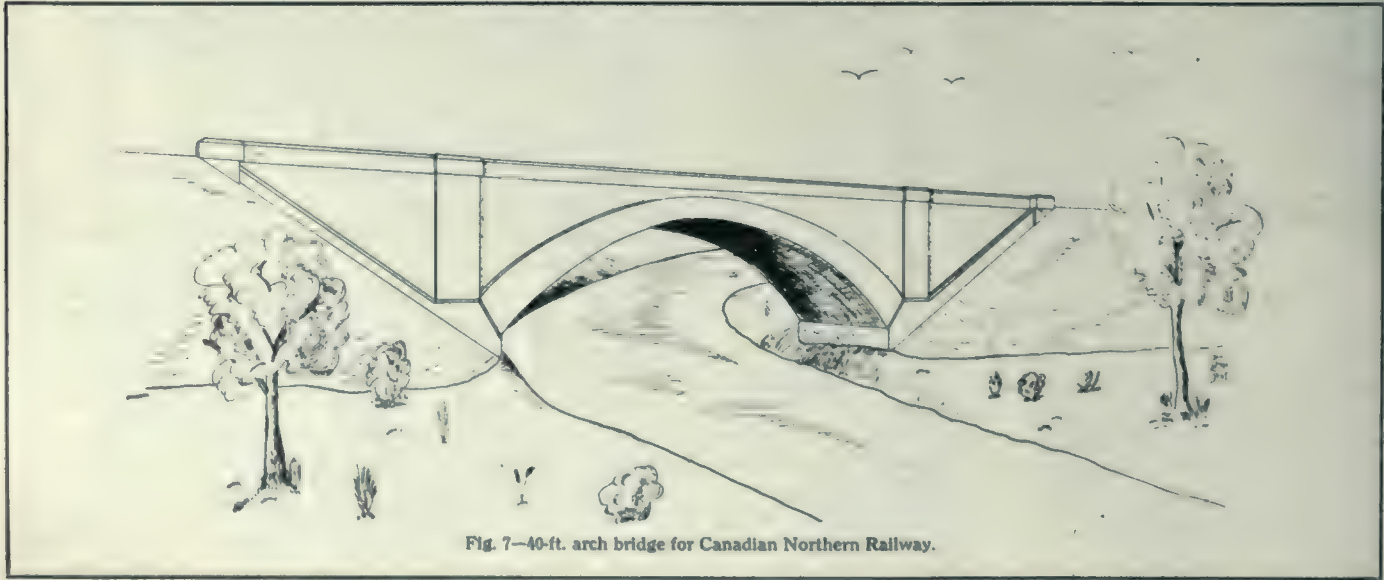


Fig. 7—40-ft. arch bridge for Canadian Northern Railway.

Figs. 6 and 7 show the details of a 40-foot arch bridge designed for use on the Canadian Northern Railway. The method of virtual work was employed. The stresses due to dead and live load were all compressive. A rise and fall of 50 deg. of temperature were considered, thus including an allowance for construction deformations. This introduced tensile stress, which was provided for by the introduction of steel reinforcement. The bridge was designed for Class Heavy, Dominion Government Specifications.

The writer considers the simplicity and appearance of strength, as shown by this bridge, to be the most effective methods of producing an aesthetic structure

Canadian Constructional Centres

A Compendium of Engineering and General Progress Data Relating to the Activities of the Principal Towns and Cities of the Dominion. Arranged Alphabetically by Provinces.

Newfoundland, Nova Scotia, P.E.I., New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia

PART II.

IN this issue we publish Part II. of the Alphabetical Reference to the towns and cities of the Dominion inaugurated in our Annual Number (May 13). In the interests of any new readers it may be well to say that this feature comprises statements relating to the engineering and general activities of the constructional centres of the Dominion. The particulars given include, as far as possible, comparative population and asessment figures, comparative returns of building and engineering work, and details as to roadways, water supply, sewerage, and garbage disposal. The articles are published alphabetically by provinces in the order given under the main heading on this page. Part I, which appeared in our last issue, comprised statements regarding the towns and cities of Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick, and Quebec, and the cities (only) of Ontario. The data available from Ontario was so voluminous that it was considered advisable to deal with the cities and towns separately. In Part II, in this issue, we give the towns of Ontario and the cities and towns of Manitoba and Saskatchewan. The feature will close next week with Part III, which will be devoted to the Alberta and British Columbia returns.

Ontario (Towns)

Barrie, Ont.

This town was incorporated in 1853. The population has dwindled from 6,800 five years ago to 6,555 in 1913, owing chiefly to the transfer of railway employees to another centre. The present assessment is three and one-quarter million dollars, which is slightly in advance of the assessment of five years ago. The tax rate last year was 25 mills. In 1909, $50,000 was expended in building, whereas the total in 1913 reached $187,530. Engineering work in the same periods total respectively $21,500 and $40,000. The town has forty miles of roadways, of which 15 are gravel, 1 concrete, 1 broken stone and the remainder earth. The estimated expenditure on road work this year is $3,000. The sewerage system is part separate and part combined and the method of disposal is by sedimentation tanks. An extension of 6,500 ft., at a cost of $10,000, and two additional sedimentation tanks, to involve an outlay of $25,000, are contemplated. Garbage is collected weekly and disposed of privately. The water supply is from artesian wells, of which there are three, from 100 ft. to 120 ft. in depth.

Bracebridge, Ont.

This town was incorporated in 1889 and has a population of 3,000, with an assessment amounting to $860,000 and a tax rate last year of 30 mills. Building amounting in value to $15,000 is the estimated expenditure contemplated for the present season. The town has thirteen miles of macadam roadways. The garbage is burned at a dump. The water is from artesian wells pumped direct to the mains from a reservoir. It is the intention to install a new pump at a cost of $3,000 in the near future.

Brampton, Ont.

This town has a population of 3,800—an increase of 700 on the returns for 1909. The present assessment is $2,000,000 as compared with 1¼ millions in 1909. The 1914 tax rate is 23 mills. In 1909 the expenditure on building was $35,000 and the 1914 estimate is $200,000, the corresponding figures for municipal engineering work being $12,000 and $35,000. There are 3½ miles of roadways, comprising asphalt block, 6,500 sq. yds.; vitrified brick, 1,800 sq. yds.; dolorway, 7,000 sq. yds.; concrete, 9,000 sq. yds., and macadam, 100,000 sq. yds. The expenditure on road work this season is placed at $10,000. The sewerage is the separate system, no storm water being allowed. The method of disposal is by septic tank, there being no filtration beds. The sewage empties from the tank directly to the River Etobicoke. Extensions to the sewerage system will be made this season at a cost of $10,000. These extensions are being planned to serve the southern portion of the town, and a new main is being installed direct to the septic tank. The garbage is collected privately once a week and burned. The water supply is from artesian wells, the water being raised by compressed air and pumped from a gathering basin to the mains, the overflow going to a 1,000,000-gallon concrete-lined reservoir, situated about three miles east of the town and connected to the distribution system by a 12-in. main.

Brockville, Ont.

This town was incorporated in 1832. Its population, which is 9,641, has remained practically constant during the last five years. Last year the assessment was $5,084,150, more than three-quarters of a million dollars in excess of that of five years ago. Last year's tax rate was 28 mills. The total value of building done in 1909 was $14,700, and $150,000 is the amount estimated for the present year. The corresponding figures for engineering work are $10,000 and $148,000 respectively. The municipality has twenty-six miles of roadways, classified thus—sheet asphalt, 1¼ miles; granite blocks, ⅛ mile; tarvia, ¼ mile; macadam, 15½ miles, the remaining 7 miles being graded. The road work for the present season is estimated to cost $27,500. The sewerage system as originally constructed was a 3-pipe system sanitary sewer, with agricultural tile laid along the side and storm sewers laid at a shallower depth. The sanitary sewers extended some years ago are still in existence. There is no disposal system in operation at present, the sewers discharging into the St. Lawrence River. Extensions to the sewerage system, estimated to cost $20,600, are divided almost equally between ordinary extensions and an intercepting sewer with pumping plant. The garbage is collected in sanitary carts and deposited on a dump. The water, which is drawn from the St. Lawrence River, is chlorinated at a pump well and pumped direct into the mains by steam power. The pumping plant consists of two Holly Gaskill horizontal pumps of 1,500,000 U. S. gals. daily capacity, and one pump (same type) of 4,000,000 U. S. gals. daily capacity. The extensions under construction consist of one 3,000,000 U. S. gal. motor-driven turbine pump, one 3,000,000 gal. capacity steam turbine-driven pump, etc., with a new power-house in addition, at an estimated cost of $47,000. Extensions to the lighting system at a cost of $10,000 are contemplated. A gas plant is in operation, the capacity of the main holder being 60,000 ft. and of the relief holder 20,000 ft. Extensions contemplated this year consist of a coal gas bench house and a 200,000 feet gas holder at an estimated cost of $40,000.

Campbellford, Ont.

This town, which was incorporated in 1906, has a population of 3,250. Its assessment in 1913 was $1,300,000 and the tax rate 20 mills. The building operations carried out five years ago totalled in value over half a million dollars. The town has twelve miles of macadamized roadways and the expenditure on road work this season will be $2,500. The sewerage system consists of two trunk sewers which empty into the Trent River. Water for domestic purposes is obtained from wells and for fire protection from the Trent River. Extensions to the electric lighting systems amounting to $17,000, are contemplated.

Carleton Place, Ont.

This town was incorporated in 1890. Its population of slightly over 4,000 five years ago has remained practically constant. The assessment last year was $1,310,156 and the tax rate 30 mills. Last year, constructional work amounting in value to $921,445 was carried out. There are ten miles of roadways, all macadamized, and about fifteen miles of granolithic sidewalks. In 1911 the town council took up the question of water supply and sewerage and having received an estimate of the probable cost submitted a by-law, which was carried. The following year plans were prepared and the contract awarded, which included the laying of about four miles of sewers and water mains. The pipe used for the latter are of steel. About three miles have been completed. Drawings and specifications for a pumping station, intake pipe, pumping machinery, filtration plant, steel water tower and sewage disposal works are in course of preparation, and contracts for these works will be let in the near future. The sewage disposal works will include sedimentation tanks in duplicate, sludge beds, chlorination house, effluent pipe, etc. The design of the tanks will be of the Imhoff type. The system will cost about $180,000. Upon the completion of these works the town contemplates the expenditure of a further sum of $50,000 on extensions. The water supply will be drawn from the river. The steel water tower to be located near the pump house will take care of the reserve supply. Regarding road building and other public works, the town will do little in the way of improvements this year, but a large expenditure in this respect is contemplated next year.

Cobalt, Ont.

Incorporated in 1906, Cobalt has a population slightly over 5,000. Last year's assessment was $4,021,153 and the tax rate 27 mills. The building programme this season is estimated to total in value $650,000. It is the intention to expend $110,000 on improvements to the six miles of streets during 1914. The garbage is collected by contract and disposed of by incineration. The water supply is drawn from the Sasaginaga Lake and is pumped by three centrifugal pumps having a total capacity of 1,800 gals. a minute.

Cobourg, Ont.

Incorporated as a town in 1850, Cobourg has a population to-day slightly under 5,300. Its assessment is roughly $2,200,000 and its tax rate for 1914 is estimated at 24 mills. There are thirty miles of streets, but so far no permanent improvements have been carried out. An expenditure of $60,000 during 1914 will be made. The sewerage system is of the ordinary type, the sewage emptying into the harbor. The Cobourg Utilities Corporation supplies the water, which is drawn from Lake Ontario. The plant consists of three 500,000-gal pressure filters.

Cornwall, Ont.

Cornwall came into existence as a town in 1847 and the population now stands at 6,500. The assessment last year was $2,100,000. The general tax rate for 1913 was 21 mills. The building estimate for the present season amounts to $10,000, an equal sum being the estimated outlay by the Engineering Department. The town has six miles of macadam and tarvia roadways and $5,000 will be expended in this department during the present year. The combined system of sewerage is in operation, disposal being into the St. Lawrence River. Garbage is collected in carts and disposed of on a dumping ground. The water supply is from the St. Lawrence River at a point some distance above the town, the plant consisting of a pump of 2,000,000 gals. capacity water tower, steel standpipe and cast iron mains. Extensions are contemplated at an estimated cost of about $3,000. A private company operates the electric lighting system in the town.

Dundas, Ont.

This town was incorporated in 1847 and has a population slightly over 4,600—an increase of some six hundred in five years. The assessment in 1913 was $2,036,600 and the tax rate in the same period 28 7/10 mills. It is estimated that $100,000 will be expended in building during the present year and $500 on engineering work. The town has twenty miles of macadam roadways. No regular sewerage system is in operation, but a special committee of the council are collecting data with a view to recommending a system for the town. A by-law at present under consideration provides for the systematic collection and disposal of garbage. The water supply is derived from springs and from Dundas Creek and is filtered mechanically.

Dunville, Ont.

Incorporated a town in 1900, Dunnville has a population of 3,330. The assessment is $1,791,325, and the tax rate last year was 25 mills. There are six and one-half miles of sewers, but there is no regular system of disposal. Extensions this season have been provided at an estimated cost of $25,000. The garbage is disposed of on a dumping ground. The water supply is from the Grand River. Last year $24,000 was expended on the waterworks system.

Fergus, Ont.

The population of Fergus is estimated at 1,700 and the town is assessed at about $800,000. The tax rate for the present year is not yet available. Building work for 1914 is estimated to total in value $60,000, and road improvements this season will involve an outlay of about $3,000, the composition of the streets being gravel and water-bound macadam. A waterworks system was installed last year, the source of the supply being artesian wells. Extensions have been planned for the present year at a probable cost of $2,000. Hydro-electric power will be in operation in the town before the end of 1914.

Fort Frances, Ont.

Fort Frances was incorporated a town in 1903 and has a population estimated at 3,000. The 1913 assessment was $2,615,000 and its tax rate 25 mills. The building programme last year totalled in value $1,209,190—an increase of nearly $1,000,000 over that of five years ago. There are over thirteen miles of roadways, composed of stone, earth and gravel, and the estimated outlay in this department this season will total about $5,000. The sewerage consists of 3.88 miles of piping, direct to the Rainy River. Extensions to the plant this year provide for some 6,000 feet at a probable cost of $10,200. The garbage is collected by wagons and dumped. The water supply is taken from the Rainy River, the plant comprising one reciprocating pump of 600 gals. capacity (driven by gas engine) and one electrically-driven turbine pump of 300 gals. capacity. Extensions planned include one electrically-driven 600-gal. pump and the laying of 15,200 ft. of 6-in. mains.

Goderich, Ont.

This town was incorporated in 1850 and its population is about 5,000. The assessment last year was $2,287,157. The roads are gravel and macadam. There is a combined system of sewerage. The sewage empties into Lake Huron, about one mile outside the town. The town's water supply is from Lake Huron and is conveyed by gravitation to settling basins and pumped to a standpipe. An expenditure of $35,000 was made recently in completing the installation of a hydro-electric system.

Haileybury, Ont.

Incorporated as a town in 1904, Haileybury has advanced in population from 2,737 in 1909 to 4,000 to-day. The assessment this year is estimated at two and one-quarter million dollars and the tax rate will probably be thirty mills. The value of building five years ago was $663,600 and the expenditure this season is estimated at $125,000. The town has 21½ miles of roadways, classified thus:—macadam, 1½; clay and gravel, 11; partly graded, 9. The expenditure on road development during 1914 is estimated at $75,000. The separate system of sewerage is in operation, the sewage being disposed of in septic tanks. There is a weekly collection of garbage—disposed of by incineration. The water supply is from Lake Temiskaming, the water being filtered mechanically. The waterworks will be extended at an estimated cost of $10,000.

Hawkesbury, Ont.

Hawkesbury was incorporated a town in 1896 and its population in 1913 was 4,374. The assessment last year was $1,061,301. The value of building last year was $652,900. There are approximately seven miles of roadways, the main street of the town being macadamized. A system of sewerage is in operation, the sewage being emptied into the Ottawa River. The collection of garbage is looked after by the local board of health. The water supply is pumped from the Ottawa River, one mile from the town, to a tank of 80,000 gals. capacity.

Kenora, Ont.

The date of Kenora's incorporation as a town is 1895. Its population to-day is 6,040, its assessment $3,351,835, and its tax rate 25 mills. Five years ago the value of building totalled $2,089,180 and the estimated value for similar work this season is $2,863,175. There are thirty-five miles of macadam roadways and the sum of $25,000 has been set aside for road improvements during 1914. The sewage is at present disposed of in Rat Portage Bay and Winnipeg River. The construction of a new sewerage system and disposal plant is contemplated, plans having been approved by the Provincial Board of Health. The garbage is dumped at present, but an incinerator plant is to be installed in the near future. The water supply is from Lake of the Woods. The water is conveyed by gravity into a well and pumped by electric power. A steam auxiliary pumping system is in use. Extensions to the electric lighting system will probably be made during 1914.

Kincardine, Ont.

Incorporated a town in 1875, Kincardine has a population of over 2,300, an assessment of $745,000 and a tax rate of 32 mills. The town expended some $46,000 on street improvements last year. The source of the water supply is Lake Huron.

Merritton, Ont.

Merritton was incorporated in 1874. Its population is slightly in excess of 2,000 and its assessment this year is $775,994. The tax rate for 1914 is 23 mills. About $460,000 represents the estimated value of building work for 1914 and $500 the engineering work. There are three miles of macadam roadways. The installation of a sewerage plant is under consideration. The water supply is from Lake Erie, and waterworks extensions to the amount of $2,000 are in contemplation. The electric street lighting will be extended at an estimated outlay of $1,200.

Mitchell, Ont.

Mitchell was incorporated a town in 1874. Its population last year was slightly below 2,000. The assessment in 1913 was $828,907 and the tax rate 24 mills. The value of building to be carried out this season is estimated at $600,000. There are twenty-five miles of gravel roads in the town and an expenditure of $6,000 is contemplated. There is no sewerage system. The water supply for domestic purposes is supplied from artesian wells and for fire purposes from the Thames River.

Mount Forest, Ont.

This town was incorporated in 1880 and the present population is slightly under 2,000. The assessment is $750,000 and the tax rate 27 mills. The sum of $2,000 was expended in 1913 on impovements to streets and roads, all of which are of crushed stone and gravel. Water is obtained from artesian wells.

Napanee, Ont.

Incorporated as a town in 1864, Napanee has a population of 3,000, an assessment roll of $1,355,487 and a tax-rate of twenty-eight mills. The roadways are macadam. The sewage disposal plant consists of slow sand filters, the effluent being conveyed to the Napanee River. A couple of short sewers are to be constructed at an expenditure of about $2,500. Water for domestic purposes is obtained from wells, and for fire protection and other purposes the supply is derived from the Napanee River and furnished to the town by the Napanee Waterworks Company.

Newmarket, Ont.

The town of Newmarket received its charter of incorporation in 1881. It has a population of 3,700 and its assessment in 1913 was $1,300,000. The water supply is obtained from artesian wells. Extensions contemplated this season include the sinking of additional wells.

Orangeville, Ont.

This town was incorporated in 1873. Its population based on last year's estimate is 2,323, and for the same year its assessment was $958,670. Its tax rate for 1913 was 27½ mills. A total of $30,000 on building and $5,000 on engineering work is the expenditure estimated for the present year. There are ten miles of clay roads, upon which an outlay of $3,000 will be made this season. The water supply is from springs. From a watershed two miles beyond the centre of the town the water is conveyed by gravity, with pressure from pumps for fire purposes. An addition is to be put in this year at an estimated outlay of $5,000.

Oshawa, Ont.

Incorporated in 1878, Oshawa has a population of 8,248, an assessment of practically three and one-quarter million dollars, and a tax rate (last year) of 29 mills. The estimated value of building work this season is $150,000, against $134,000 in 1910. In engineering work, $53,000 is the expenditure estimated for 1914, against $27,719 in 1909 and $55,681 last year. The town has twenty-six miles of paved streets, the classification being: asphalt block, bitulithic, vitrified brick, concrete and macadam, to the extent of about six miles, the remaining twenty miles being graded and gravelled. The municipality intends laying about one mile of concrete road in the northern and western sections of the town during 1914, at an estimated outlay of $11,000. There is a separate sewerage system. The disposal is by sedimentation tanks of 100,000 gal. capacity. Garbage is deposited on a dump. Lake Ontario is the source of the water supply, which is conveyed by a 12-in. intake extending 1,130 feet into the lake. A water tower capable of holding 250,000 gallons also forms part of the plant.

Parry Sound, Ont.

Incorporated as a town in 1889, Parry Sound has a population of 3,300. Its assessment is $1,764,000 and its tax rate last year was 21 mills. The value of last year's building programme totalled $1,023,995. A bylaw is being submitted to the ratepayers to expend $26,000 on improvements to streets and sidewalks. There are sanitary sewers on the principal streets. The Georgian Bay is the source of the water supply, which is pumped to a steel tank. If the bylaw meets with the approval of the ratepayers, an expenditure of $7,000 will be made in extensions to the system.

Pembroke, Ont.

In 1877 Pembroke received its charter as a town. In 1909 its population was 5,600 and at the present time it is 7,000. The assessment is $3,169,730 compared with $2,534,265 five years ago. Its tax rate for 1914 is 25 mills. The value of building to be carried out this season is estimated to total $212,000, and engineering work $30,000. The roadways are water-bound macadam. There is a separate system of sewerage, the sewage being discharged into the Ottawa River. Garbage is collected in carts and deposited on a dump. The Ottawa River furnishes the water supply, which is taken through an 18-in. steel intake, motor-driven turbine pump, with auxiliary steam pumps, steel and cast iron pipes. Extensions to the distribution system are contemplated at an outlay of $5,000.

Petrolia, Ont.

Petrolia came into existence as a town in 1874. Its population has advanced from 3,670 five years ago to 4,019 today. Its assessment is $1,542,270 and its tax rate for 1913 was 31 3/5 mills. The 1914 building programme is estimated to total in value $75,000, and that of engineering work $10,000. The town possesses ten miles of roadways, made up of eight miles of ordinary clay roads, one mile of vitrified brick and one mile of asphalt. The sewerage system comprises four main trunk sewers emptying into Bear Creek. There is no regular system of garbage collection. The town's water supply is pumped from Lake Huron, a distance of fourteen miles, conveyed through a 12-in. main, with standpipe capacity of 250,000 gals. The capacity of the pumps at Lake Huron is 1,000,000 gals. daily.

Prescott, Ont.

Prescott has a population of 3,000 and an assessment of $1,314,207. Its date of incorporation as a town is 1860 and its tax rate—on last year's estimate—is 27½ mills. Of ten miles of streets one mile is macadam, the balance being ordinary surface. An expenditure of $1,000 will be made in road improvements this year. There is an ordinary system of sewerage, the sewage emptying into the St. Lawrence River. The water supply is obtained direct from the St. Lawrence River.

St. Mary's, Ont.

This town has a population of practically 4,000 and an assessment of about $2,000,000. The total value of building work this season is estimated at approximately $200,000. Four artesian wells furnish the water supply, which is pumped into a standpipe. There are steam and electric pumps, each of 1,000,000 gals. capacity. Minor extensions to the waterworks will be made this season. A new street lighting system will be installed in the near future.

Sarnia, Ont.

This town was incorporated in 1857 and application for a city charter is being made this year. The population last year was 11,000 and the assessment $5,271,600, with a tax rate of 26¼ mills. The value of building carried out last year totalled $3,044,555, the expenditure on engineering work being $10,000. There are forty miles of roadways, their composition being creosote, wood block, asphalt block, brick, concrete and earth. The sum of $200,000 has been set aside for road improvements this season. The sewerage system comprises three main outlets to the River St. Clair. It is proposed to expend $22,000 on the construction of a 60-in. concrete pipe, at an estimated cost of $14,000, and 24-in. sewer tile, at an outlay of $8,000. A garbage incinerator will probably be constructed this year. The water supply is drawn from the River St. Clair. The water is pumped by a 5,000,000-gal. Inglis reciprocating pump and a 3,000,000-gal. Worthington pump. It is proposed to expend $220,000 on extensions to the plant by constructing—an open filtration gallery and reservoir, at a cost of $65,000; pumping plant consisting of steam turbine-driven pump of 6,000,000 gals. capacity and one Inglis reciprocating pump of 5,000,000 gals. capacity, at an estimated value of $75,000. A 24-in. steel main will also be laid at an expenditure of $80,000.

Seaforth, Ont.

This town has a population of 2,000 and was incorporated in 1874. The assessment for 1914 is $960,000 and the tax rate (last year) was 31 mills. The streets are of asphalt block, macadam and gravel, and the water supply has its source in Silver Creek.

Smith's Falls, Ont.

Smith's Falls was incorporated as a town in 1883. It has a population of 6,550, an assessment of $3,700,000 and a tax rate of 21½ mills. The value of building last year amounted to $222,000 and the building programme for the present season is estimated to amount in value to $100,000. Five years ago the engineering department expended $20,000, chiefly on sewers and walks. Last year the outlay by the engineering department was $38,000 and for 1914 the amount estimated is $20,000. The town possesses about forty miles of roadways, all of which are macadamized, and $100,000 has been set aside for road improvements this year. There is a combined sewerage system, the sewage being disposed of in the Rideau River, from which source the town's water supply is also drawn.

Steelton, Ont.

Steelton was incorporated a town in 1904. Its population of 2,700 in 1909 has increased to 5,506 to-day. The assessment this year is $2,661,706, of which $1,991,180 is covered by specific tax paid by the Algoma Steel Company's Industrial Works. The roads are slag, tar macadam and concrete. The sewage is disposed of untreated into the St. Mary's River. Extensions to involve an outlay of $27,000 will be carried out in the eastern and western sections of the town. The source of the water supply is the St. Mary's River. Water is purchased from the Tagona Water & Light Company, who supply the city of Sault Ste. Marie. The feasibility of an artesian well supply is being investigated and if found practicable a pumping plant will be installed.

Strathroy, Ont.

The population of Strathroy is slightly over 3,000. Last year's assessment was $1,151,735 and the tax rate 25 mills. The value of building done five years ago represented a total of $124,800, as against $992,530 last year. Twenty miles of roads, sand and block paved. There is a sewerage system in operation. The garbage is dumped. The water supply is drawn from artesian wells. An expenditure of $25,000 on a hydro-electric installation is contemplated.

Sudbury, Ont.

Incorporated as a town in 1894, Sudbury has exactly doubled its population, which in 1909 stood at 4,000 and which to-day is 8,000. The assessment for the previous year is three and one-half millions, against $1,700,000 five years ago. The tax rate last year was 12.5 mills. The value of building done in 1909 was $250,000 and the estimated total for this season is $1,000,000. The expenditure estimated under the head of engineering is $150,000. There are thirty miles of roadways, composed of rocmac, macadam, gravel and earth. An expenditure of $150,000 on road improvement this year is estimated. The sewerage system comprises one main trunk sewer with laterals. For the lake section there is a pumping plant, compressed air and Priestman ejectors being in use, the sewage discharging into the trunk sewer. The provision of sedimentation tanks is contemplated and other proposed improvements in the system embrace the extension of the trunk sewer and the construction of additional sanitary street sewers. The garbage is dumped. The water supply is obtained from Ramsay Lake within the town limits, the plant consisting of a pumping station, two motor-driven turbine pumps of 1,440,000 gals. daily capacity, two compound steam pumps of 3,168,000 gals. capacity and one steel elevated tank having a capacity of 64,000 gals. Extensions to the waterworks plant will be made at an estimated cost of $10,000. A similar amount will be expended on ornamental street lighting.

Tilsonburg, Ont.

Tilsonburg was incorporated a town in 1872. Its population of 2,200 five years ago has advanced to 3,000. Its assessment for 1914 is $1,500,000 and the tax rate 25 mills. The total value of building done in 1909 was $732,000. The estimated value of the building programme for this season is $1,000,000. There are ten miles of streets and roadways, a large percentage of which are macadam. The town sewage is disposed of in sedimentation tanks. The water supply is obtained from springs.

Walkerville, Ont.

The town was incorporated in 1890 and has a population of 5,000. Its tax rate this year is 10 mills. The expenditures on engineering work this season is expected to total close on to $25,000. There are practically fourteen miles of roads, classified as follows:—asphalt block, bitulithic, cedar block and concrete. The town is served by a main drainage system, the sewage being discharged into the Detroit River. Extensions planned consist of the construction of about 3,000 ft. of sewer at an estimated cost of $4,800. Garbage is collected in wagons and disposed of by incineration. The source of water supply is the Detroit River.

Waterford, Ont.

Waterford has a population slightly over 1,000, an assessment of $491,000, and a tax rate of about 20 mills. About ten miles of gravel roads are controlled by the local authority and the water supply is drawn from wells. No constructional improvements of any kind are contemplated this year.

Welland, Ont.

Welland came into existence as a town in 1878. It has a population of 8,000, which is practically double that of five years ago. The estimated assessment for the present year is $4,888,525, and its tax rate is 25 mills. The expenditure on building this season will probably reach three-quarters of a million dollars. The road mileage is 22, 18 of which are earth, 2 of brick, 1½ macadam and ½ mile slag. The sum of $30,000 has been set aside for road improvements this season. Welland has a combined system of sewerage, the sewage being disposed of in the river. There will probably be an expenditure of $15,000 on sewerage extensions this year. Garbage is collected weekly and dumped outside of town limits. The Welland Canal is the source of the water supply. Waterworks extensions will involve an outlay of about $12,000. The electric lighting plant will be extended at an estimated cost of $20,000.

Weston, Ont.

This suburb of Toronto, which is now a town of some twenty-five hundred inhabitants, was first incorporated as a village in 1883. The assessment last year was $1,444,466. The tax rate this year is 22½ mills. There are fifteen miles of macadam and gravel roadways at Weston. The sewerage system consists of about ten miles of sanitary sewers, a storm sewer on Main street and a 26-in. storm trunk sewer one mile in length. The method of disposal is by sedimentation and revolving sprinklers with stone filter. The garbage is deposited on a dump. Water is obtained from the Humber River and subjected to mechanical filtration. Extensions to the waterworks this year will cost $2,000 and to the electric light plant, $10,000.

Manitoba

Brandon, Man.

The city of Brandon was incorporated in 1885. It has a population of 18,000, an increase of more than fifty per cent. in the last five years, during which period the assessment has increased from nine and one-half millions to more than fourteen millions. In 1909 the value of building work carried out was $350,000, as compared with an estimate of $1,000,000 for 1914. The engineering expenditure for 1909 was $205,000. No complete estimate of municipal engineering work for 1914 is obtainable at the time of writing, but $75,000 will be spent on roadways, $80,000 on sewerage extensions and $120,000 on waterworks. The roadway mileage is fifty-four, made up as follows:—graded and gravelled roads, 23; graded only, 27; asphalt block,, 3; rocmac, one-half; macadam, one-half. The city is divided into four sewer districts, and the sewerage is the combined system. At present the sewage is discharged into the Assiniboine River. The city contemplates putting in a sewage disposal system at a cost of $80,000. The garbage is collected by the city and deposited on a nuisance ground. The purchase of an incinerator is under consideration. The city's water supply is from the Assiniboine River. Mechanical pressure filters are used and settling basins with gravity filters are contemplated.

Carman, Man.

The town of Carman was incorporated in 1905. Its population of 1,300 in 1909 has increased 300 in the five years to date, and in the same period its assessment has increased from $676,000 to $900,000. The 1914 tax rate will be probably 24 or 25 mills. The estimate for building work this year is $75,000. There are about seven miles of earth roads. Fifteen hundred dollars will be spent on road work this season. The sewage empties into the Boyne River. The garbage is deposited on a nuisance ground and burned. The town's water is obtained from wells, water required for fire protection and other purposes being pumped from the river to an elevated tank.

Emerson, Man.

Emerson was incorporated a town in 1889. Its population is practically 1,000 and its assessment last year was $404,000. There are thirty miles of earth roads, on which $1,500 will be expended this season. The water supply is derived from wells and from the Red River. An expenditure of $200,000 on an electric lighting plant is contemplated.

Minnedosa, Man.

This town, which has a population of 2,000, received its charter in 1885. During the last five years the population has increased 650. The assessment and tax rate last year were $1,557,000 and 21 mills respectively. It is estimated that $10,000 will be expended on building and engineering work this season, the amount being equally divided. There are 12 miles of earth roadways. The water supply is from wells. There is no sewerage system. The garbage is dumped.

Neepawa, Man.

This town received its charter in 1884. It has a population of 2,300 and its assessment is $1,210,000 as compared with a population of 1850 and an assessment of $813,200 in 1909. The tax rate last year was 28 mills. During 1912 and 1913 the engineering work carried out by the municipality represented an expenditure of $146,000, and the 1914 estimate is $50,000. The sum of $5,000 will be expended on road work this year. The town has fifteen miles of gravelled roads. The method of sewerage disposal is by septic tank and filtration. Sewerage extensions to the value of $5,000 will be made this season. Garbage is collected by teams and burned. The water supply is pumped from the river and is filtered. The waterworks extensions planned this season will cost $5,000. The electric light system is to be enlarged at a cost of $18,000.

Portage la Prairie, Man.

Portage la Prairie became a town in 1881 and a city in 1907. Its population of 6,490 in 1909 has increased to 7,000 to-day. The assessment in 1913 was $6,000,000, and the tax rate this year is about 24 mills. The city has about thirty miles of ordinary graded roads and contemplates an expenditure of $9,000 on street and road improvements this year. The sewage is pumped and discharged into the Assiniboine River. The source of the water supply is the Assiniboine River, the water being filtered through sand galleries.

Selkirk, Man.

The town of Selkirk was incorporated in 1882. Since 1909 its population has increased from 2,900 to 3,500, its assessment from $2,000,000 to more than $4,000,000, its building expenditure from $4,000 to $50,000 (estimate for 1914) and its municipal engineering expenditure from $4,500 to $60,000 (estimate for 1914). The 1913 tax rate was 19 mills. There are about eighteen miles of graded roads. The estimated expenditure on road work this season is $7,000. The sewage is discharged untreated into the Red River. The sewerage extensions contemplated will cost $16,450. The garbage is deposited upon nuisance grounds. The water supply is from a well. Waterworks extensions planned will cost $16,150. Extensions to the electric light system will be made this season at a cost of $5,000.

Souris, Man.

This town was incorporated ten years ago and has a population of 2,500—an increase of 900 since 1909. The assessment is $1,355,000 as compared with $755,000 in 1909. The 1914 tax rate is 26 mills. Building work to the value of $60,000 and municipal engineering work to the value of $18,000 are contemplated this season, these figures comparing with expenditures of $8,000 and $5,000 in 1909. The town has thirteen miles of gravelled roads and two miles of granolithic walks. Five thousand dollars will be expended on road work this season. The sewerage consists of eight miles of sewers 8-in. to 20-in. in diameter, with an inverted syphon under the Souris River, leading to the disposal works. Septic tanks and filter beds are used in the disposal of the sewage, the effluent being discharged into the Souris River after treatment. The extension of the sewerage in West Souris is to be carried out this year at a cost of $7,800. The garbage is collected under contract and is deposited on a nuisance ground. The water supply is from two wells 185 ft. deep. The town has two 82 h.p. pressure gas engines, and the water is raised from the wells by the Harris Air Lift system, after which it flows by gravity to the reservoir, which has a capacity of 90,000 gallons. Further equipment consists of two Worthington turbine pumps and compression tank system. Waterworks extensions to West Souris are planned at a cost of $6,900. The electric light system, which was installed last fall, is operated jointly with the waterworks plant. The system is direct current with storage battery manufactured by the Hart Accumulator Company, Limited, London, England.

St. Boniface, Man.

St. Boniface received its town charter in 1883 and its city charter just twenty-five years later. During the last five years its population has practically doubled, it having increased from 6,078 in 1909 to nearly 12,000 to-day, during which period the assessment has increased from nine and one-half millions to over eighteen millions. The expenditure on building work in 1909 was $1,625,395 and on engineering work, $650,000. The 1914 estimates are rather less than $4,000,000 for building work and $175,000 for municipal engineering work, of which $600,000 will be spent on new bridges. There are seventeen miles of roadways in St. Boniface, the types being creosoted block, bitulithic, asphalt block and cedar blocks. The estimate for 1914 road work has not been taken up at the time of writing. The sewerage is the combined system, there being six outlets to the Red River. There are thirty-nine miles of sewers, of which six are trunk. Sewerage extensions contemplated this season involve an expenditure of $50,000. The garbage is collected in wagons and deposited on a dump. The water is pumped from four wells to an underground reservoir (capacity 1,000,000 gallons) by a motor-driven air compressor and air lift pumps. From the reservoir it is pumped into the city mains though an elevated tank 145 feet high by two motor turbine pumps having a capacity of 1,500,000 gallons every 24 hours under a pressure of 100 pounds per square inch. The substructure for the new bridge over the Red River between Winnipeg and St. Boniface is almost completed and tenders are now being called (close. June 20) for the superstructure. This will be a half-through plate girder bridge with a two-leaf Strauss bascule bridge lift span, and will cost approximately $600,000, of which the city of Winnipeg will pay one-third. The bridge has a 46-foot clear roadway and two 10-ft. sidewalks.

Winnipeg, Man.

The capital of Manitoba, the economic centre of the Canadian West, has grown from a Hudson's Bay trading post with a population of 215 to a city of 225,000 in 44 years. The city received its charter in 1874 when there were 1,869 inhabitants. Perhaps the most illuminating instance of the city's growth may be found in recent years, the population having increased from 122,390 in 1909 to 225,000 to-day. In 1909 the assessment was practically $108,000,000, while last year it was $260,000,000. The building permits issued in 1909 represented the expenditure of nine and a quarter millions, while the estimate for the present year is twenty millions. During the last seven years Winnipeg has expended approximately $150,000,000 in new buildings. The roadway mileage is 464, classified as follows: asphalt macadam, 13.5; sheet asphalt, 84.7; cedar block, 26.0; macadam, 33.1; concrete, 1.8; graded roads, 264.2; unimproved roads, 40.7. In the way of road work this season it is intended to carry out sheet asphalt paving (details of which are on file at the office of the Contract Record) totalling nearly 94,000 square yards. It is expected that 30,000 square yards of granolithic walk will be put down this year and 17 miles of plank sidewalks. The sewerage system, briefly, is a combined system discharging through twenty-five outlets into the Red and Assiniboine Rivers, the method of disposal being by dilution. The sewerage extensions planned this season involve an expenditure of $390,000, to be spent principally on the construction of laterals. While some sewers have already been constructed and others are under way, the specific work yet to be done has not been definitely decided upon. The garbage is collected in wagons and disposed of by incineration. The city has three incinerators:—No. 1, built by the Toronto Furnace Company, has a capacity of 60 tons a day; No. 2, built by the city, has a capacity of 100 tons a day, and No. 3, built by the Decarie Company, has a capacity of 160 tons a day. The city's water supply is obtained from artesian wells. The waterworks extensions planned this year will cost $385,000. This amount includes $195,000 for mains (details not decided on), $30,000 for meters, and $60,000 for new services. Besides this, $300,000 will be expended on extensions to 36-inch pipe line and well system. The distribution of the one-million-dollar appropriation for electric light and power extensions has not been detailed. In all probability $700,000 will be expended on extensions to generating plant, transmission line, improvement of railroad (including a bridge) and the balance on extensions in the city, viz., overhead lines, new synchronous sets, and buildings.

Saskatchewan

Battleford, Sask.

This town has a population of 2,300 and was incorporated in 1904. The assessment is in the neighborhood of $4,500,000 and the tax rate 14 2-5 mills. Building work for the present season is estimated to total in value $150,000 and the amount set aside for engineering construction $100,000. There are five miles of streets and sidewalks, all of which are graded. It is proposed to expend $1,000 on road improvements this season. There are four miles of sewers discharging into the Battle River. The system of sewage disposal is by combination sedimentation tank and percolating filters, Ham Baker travelling distributors being used. Extension work is at present under construction at an estimated cost of $70,000. The garbage is collected by scavenger and dumped. The water supply is drawn from wells in the neighborhood of the Saskatchewan River. The system consists of duplicate submerged centrifugal pumps, pumping against a 100-ft. head to a reservoir of one hundred thousand gallons capacity, from whence it is conveyed by turbine pump to two 18,000-gal. tanks. Waterworks extensions will cost $25,000.

Canora, Sask.

Incorporated as a town in 1910, Canora has advanced in population from 300 in 1909 to 1,400 to-day. The assessment in 1913 was rather more than $2,000,000 and the tax rate 18 mills. The value of building during 1913 was $388,000. There are about four miles of gravel roadways. A sewerage system is being installed, also water supply, the source of which will be Crystal Lake, 14½ miles from the town.

Davidson, Sask.

This town was incorporated as recently as 1906. The population is 650, an increase of 200 in five years, during which time the assessment of $300,000 (in 1909) has doubled. The 1914 tax rate is 18 mills. Building operations this year are estimated to cost $20,000. Garbage is collected by scavengers and dumped. The town's water supply is from three main wells, with a motor pump in operation. The lighting system is to be extended this season at a cost of $10,000.

Lloydminster, Sask.

This town has a population of 1,000 (600 in 1909) and an assessed value of $554,000. The 1913 tax rate was 16 mills. The roadway mileage is nil and there are no systems of sewerage or garbage disposal. The water supply is obtained from wells and the electric light is furnished by private plant.

Melville, Sask.

Melville became a town in 1909. Its growth is evidenced by the fact that its population has advanced from 500 in 1909 to 3,500 to-day. The estimated assessment for 1914 is $3,750,000, and the tax rate 20 mills. The building programme this season is expected to total $350,000, while $150,000 has been set aside for engineering works. The mileage of graded roads is fifteen. Road improvements involving an expenditure of about $12,000 are contemplated. A regular sewerage system has not yet been constructed, but an installation at an actual outlay of $82,000 is planned. Garbage is collected by scavengers and dumped. The water supply is from deep wells distributed by means of air pressure tanks, or in case of fire pumped into the mains direct. Extensions to the waterworks system estimated to cost $13,000 will probably be made during 1914.

Moose Jaw, Sask.

In common with most western centres, Moose Jaw has advanced with marked rapidity. Incorporated a city in 1903, Moose Jaw had a population three years later of 6,250. This has now advanced to 30,000. The assessment last year was approximately $52,000,000 and the tax rate 17 mills. Details of building expenditure are not available, but it is estimated that $1,300,000 will be expended this season in engineering work. The mileage of streets and roadways is 180, apart from subdivisions, all roads being graded. An expenditure of $120,000 on road improvements is contemplated. The sewage is pumped to separator tanks, which, with percolating filters, are the method of disposal. The effluent undergoes a process of disinfection and the sludge is dried and burned. Extensive improvements to the system are contemplated at an outlay of practically $360,000, apportioned as follows:—extensions to sanitary sewers, $212,000; extensions to storm sewers, $115,000, and extensions to disposal plant, $30,000. The ratepayers have just approved a bylaw to raise $301,000 for sewerage and waterworks extensions, details of which are given in the News Department of this issue. The garbage is collected by city teams and disposed of by a Heenan & Froude about twenty miles west of Moose Jaw, an auxiliary supply incinerator. The water supply is obtained from Sandy Creek, being available from Snowdy Springs, eight and one-half miles south-west of the city. The system comprises a tile infiltration gallery into which water filters through sand and gravel. Extensions comprising about ten miles of 6-in. to 12-in. mains are planned at an estimated outlay of practically $200,000. The electric lighting system will be extended at a cost of $155,000.

Moosomin, Sask.

The town of Mossomin was incorporated twenty-five years ago. It has developed slowly, the present population of 1,300 being an increase of only 100 in the last five years. The 1914 assessment is one and one-quarter million dollars and the tax rate this year is 25¾ mills. There are no municipal improvements with the exception of the waterworks. the water supply being taken from a well and the equipment consisting of a 100,000 gal. standpipe. There is no electric light ystem, acetylene gas furnished by a private company being used.

North Battleford, Sask.

Incorporated as a town as recently as 1907, North Battleford received its city charter only last year. It has a population of nearly 7,000, compared with 1,500 in 1909. The assessment is roughly $10,000,000, as compared with $1,000,000 in 1909. In 1909 the value of municipal engineering work carried out was $60,000. This year's estimate is $350,000. The building work projected involves an outlay of $1,500,000. There are no permanent pavements in the city. The sum of $70,000 will be spent on grading and gravelling this season. A separate system of sewerage is installed, the method of disposal being by two sedimentation tanks, with sub-surface filtration for the tank effluent and two sludge beds. The sewerage system is to be extended this year by the installation of sewage filters at a cost of $8,000. Garbage is collected by the city and deposited on a nuisance ground. Water is obtained from wells on the bank of the Saskatchewan River. There is one steel well, 35 ft. in diameter and 25 ft. deep, and one concrete well, 25 ft. in diameter and 22 ft. deep, situated in sandy soil 50 ft. from the river bank. Water is pumped to the standpipe by electric and gasoline power and conveyed to the city, two miles distant, in one steel and one cast iron force main. The storage capacity is 500,000 Imp. gals. All the services are metered. This season it is planned to extend the waterworks system at a cost of $70,000 by enlarging the pumping station and adding to the distribution system. Extensions to the electric light system are to be made this year at a cost of $25,000, the new work to consist of pole lines and ornamental system. Additional boilers will be installed.

Prince Albert, Sask.

The town of Prince Albert came into existence in 1885 and received its charter as a city ten years ago. The population to-day is 13,500, as compared with 5,000 in 1909, the assessment being rather more than 31,000,000 as compared with five and a half millions in 1909. The 1913 tax rate was 11 mills. The value of building in 1909 was $142,000, while the 1914 estimate for building work is $1,750,000 and for municipal engineering work $250,000. In the construction field contracts for the new R. C. cathedral, armoury building and telephone exchange were let recently. The roadway mileage is 35, the classification being: earth, 33; gravel, 1; macadam, 1. All underground work, such as water and sewer services. conduits for carrying electric light and telephone wires, are being installed by the city with the idea of preparing a programme of constructing each year for the next few years about 50,000 sq. yds. of pavement. Plans and specifications are in course of preparation for removing the present grade crossings in the heart of the city and of placing the railway tracks just under the brow of the hill, crossing these tracks on the various avenues by reinforced concrete viaducts, the estimated final cost of the scheme being $800,000. The sewerage installed is a separate system. There are three pumping areas with a trunk sewer across the city. At present there is no method of disposing of the sewage, but a scheme is under consideration. The sewerage extensions planned this year involve an expenditure of $75,000. Garbage is collected by wagons and dumped on a nuisance ground. The water supply is drawn from the North Saskatchewan River. There is a mechanical filtration plant in operation. Extensions to the waterworks will be made this season at a cost of $125,000. The dam at LaColle Falls, situated twenty-five miles down the North Saskatchewan River from Prince Albert, has been partially completed by the city. The construction of this plant will render cheap power available for pumping purposes. electric light and power services, the street railway and also for the various mills and power users within the city. An Ottawa syndicate is at present in negotiation with the city to install a complete street railway system at an estimated cost of $250,000. In the event of satisfactory arrangements being made it is expected that work will start this summer and that six miles of railway will be in operation before the end of the year.

Regina, Sask.

The capital city of Saskatchewan was incorporated as a town in 1883 and as a city just twenty years later. The increase of population in recent years has been on the same spectacular scale as at Saskatoon, the figures for 1914 and 1909 being 50,000 and 12,000 respectively. The net assessment in 1909 was, roughly, $12,000,000, as compared with $73,000,000 to-day. The 1914 tax rate is estimated at 16 mills, the building expenditure at $4,000,000 and the municipal engineering work at $2,500,000. In 1909 the building work was valued at $750,000 and the engineering work at rather more than $300,000. The roadway mileage is 101, there being twenty-six miles of pavements, with the balance granolithic and plank sidewalks. The expenditure on road work this season is placed at $800,000. There are 61 miles of sewers with 5,100 house connections. A new separate system is in operation The method of disposal is sedimentation and filtration. The 114 extensions to the sewerage systems comprise two additional filters at a cost of $75,000, twelve miles of domestic sewers at a cost of $138,000 and seven and one-half miles of stone sewers at a cost of $170,000. The garbage is collected by the City Scavenging Department and transferred from a central refuse station over the street railway to an incinerating plant of 110 tons capacity. The city's water supply is from the Boggy Creek watershed. The city has one 5-million gallon reservoir, one 18-in. and one 10-in. supply main, and 59 miles of distributing mains. This season the water system is to be extended by thirteen miles of distributing mains, estimated to cost $120,000, while sewer and water connections and water meters will involve another $360,000. The electric light system is to be enlarged by line extensions, apparatus. buildings, etc., at a cost of $400,000.

Saskatoon, Sask.

Saskatoon is one of the whirlwind cities of the west, it having received its city charter in 1906 only three years after its incorporation as a town. Its population of 7,500 in 1909 has now increased to 30,000. Following are further comparative returns in round figures: assessment, 1909, $8,000,000; 1914, $54,000,000; value of building construction, 1909, $1,000,000, 1914 (estimated), $2,300,000; value of municipal engineering work, 1909, $423,000; 1914 (estimated), $634,000. The 1914 tax rate is estimated at 17½ mills. The roadway mileage is 58.63, made up as follows:—graded earth roads, 53; bitulithic pavement, 2.63; street asphalt, 1.41; sandstone block, .82; asphaltic concrete, .54; wood block, .23. The 1914 expenditure on road work is placed at $50,000. The city is situated on the banks of the South Saskatchewan River, along the north shore of which an intercepting sewer, 3 ft. by 6 ft. in diameter, has just been completed. This sewer intercepts all the sewer outlets in the city, with 24-in. inverted syphon and another 24-in. pipe line under the river, the latter to be pumped. These two pipe-lines carry the sewage across the river to the main interceptor, which will carry all the city's sewage to a point below the city where a disposal plant is to be constructed in the near future. The extensions planned this season comprise storm and sanitary sewers at a cost of $100,000. The garbage is collected by teams and burned in an open field. An incinerator plant is contemplated. The water is brought from the South Saskatchewan River through a 35-in. cast iron intake pipe and a 12-in. intake pipe into a shore well, from which it is raised by centrifugal pumps into a sedimentation basin. From this basin it flows by gravity to the filtration building, where it is purified in a plant constructed by the Roberts Filter Company, of Philadelphia. After filtration it flows to the pumping station and is forced into the distribution system by electrically-driven, centrifugal pumps. The extensions planned this season comprise a sedimentation basin, estimated to cost $60,000. Of the interesting work under contract special mention must be made of a reinforced concrete arch bridge 1,543 ft. long, the cost of which will be in the neighborhood of $500,000. The construction is composed of ten arch spans varying from 25 ft. to 150 ft. Extensions to the electric lighting system planned this season involve an outlay of $200,000.

Weyburn, Sask.

Incorporated as a town in 1903 and as a city in 1913, Weyburn has a population of 5,500, as compared with 1,100 in 1909. The assessment to-day is roughly $10,000,000. In 1909 it was one and one-quarter millions. Little has been done in the way of road work, but this year there will be an expenditure of $5,000 and an equal amount on concrete sidewalks. The sewers carry domestic sewage only and drain to an ejector station near the power house, where the sewage is pumped to the disposal works one mile distant. The sewage is passed through sedimentation tanks, filtered, and the effluent disinfected before being discharged into the Souris River. The sewerage extensions for 1914 will cost $32,000, made up as follows:—sewage filter, $15,000; street sewers, $15,000, and house connections, $2,000. Garbage is collected weekly by city teams and burned on a nuisance ground. Water is collected in wells and pumped to a water tower in the city. The waterworks extensions planned involve an expenditure of $40,000, and are as follows:—collecting gallery at wells, $30,000; street mains, $7,000; house connections, $3,000. Extensions to the electric light system will be made at a cost of $20,000.

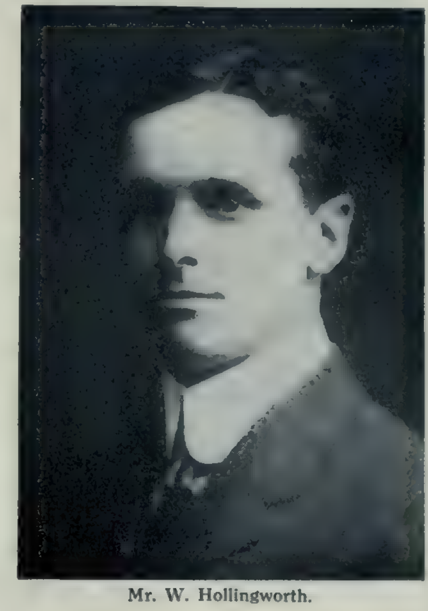
Yorkton, Sask.

This town received its charter in 1900. Nine years later it had a population of about 1,250, which has grown to nearly 6,000. Last season's assessment was roughly $8,000,000 as compared with $1,300,000 in 1909. The tax rate for 1913 was 17 mills. The estimated expenditure on municipal engineering work this year is $375,000, this comparing with an outlay of $40,000 for 1909. There are twenty miles of gravel roadways. The sum of $4,000 will be expended on road work this season. There are nine miles of sewers. The disposal works consist of a sedimentation basin and Stoddart trays. This season's extensions comprise the completion of the outflow sewer, 42-in. in diameter and 5,600 ft. long, at a cost of $40,000. The garbage is deposited on a dump. The water supply is obtained from wells 55 ft. deep. There are eight and one-half miles of water mains. The installation of a new water supply from York Lake, four miles distant, is under consideration, the work involving an expenditure of $100,000. The electric light system is to be extended at a cost of $200,000, details being as follows:—new power house; 1,000 h.p. Diesel combined units and ornamental tungsten standards; pole line extensions.

(For Part III—Towns and Cities of Alberta and British Columbia—see next issue.)

Mr. Wilfrid Hollingworth, Deputy City Engineer of Hamilton

Mr. Wilfrid Hollingworth, A. M. Can. Soc. C. E., whose article on the Hamilton waterworks was an interesting feature of our last issue, is deputy city engineer of Hamilton, a position to which he was appointed in 1911. Mr. Hollingworth hails from Lincoln, Eng., where he received his professional training in the technical schools of that city and in a four years' apprenticeship to Mr. R. A. MacBriar, city engineer of Lincoln. Upon the completion of his apprenticeship he was appointed Resident Engineer on sewage disposal works in Gloucester, an extensive undertaking which comprised five separate plants on the Cameron system and fifteen miles of main sewers. Mr. Hollingworth left the Old World for the New in 1904 and coming to Toronto made connections with his profession as engineer in charge of the design and construction of a small hydro-electric plant for the Erindale Power Company. In 1905 he was appointed assistant engineer under Mr. C. H. Rust, and had charge of various municipal works, including the Woodbine sewage disposal plant and other special works. In 1908 he was placed in charge of the construction of the Toronto main drainage system, for which the sum of $2,400,000 had been appropriated. He remained in the service of the city of Toronto in the above capacity until 1911 when he succeeded to his present office in Hamilton under City Engineer Macallum. Mr. Hollingworth is well and favorably known in his profession among the younger and more aggressive set. He takes a keen interest in Society work.



Mr. W. Hollingworth.

At Lethbridge, Alta., a new English church, hall and rectory are to be erected at a cost of $150,000. The architects are Messrs. Clemesha & Portnall, of Regina.

The extent of local improvements in the various municipalities in Saskatchewan is shown by the fact that during the four months of existence of the Saskatchewan Local Government Board, debentures for $5,540,752 were authorized. Of that amount, school districts received authorization to issue debentures amounting to $689,225; rural telephone companies, $361,400; rural municipalities, $6,000; towns, $289,400; villages, $8,900, and cities, $4,185,827. Almost half the debentures being issued by the seven cities of Saskatchewan are those providing for local improvement works at Regina.

The Artistic Possibilities of Bonds and Mortars in Brickwork*

(Registered in accordance with the Copyright Act.)

Part I.

BRICK walls offer more varied architectural possibilities than they usually receive credit for, either from the architect or the builder, and in no respect is this more apparent than in lack of knowledge appertaining to the skilled use of bonds and mortars. There are many good architects and many good builders who have yet to learn that bonds and mortars do not concern merely the dull prosaic mechanics of cementing bricks together and building them into a solid wall, but that treated intelligently in connection with the textures and colors of the bricks themselves, they offer the most flattering artistic opportunities. Let the designer in brickwork but know what his building is to be and where it is to be—a modest or a pretentious dwelling in town or country, a great block in the metropolis, or a store in the village street, a city hall, a school of learning, or a temple of worship—and he has within his hands the fine warp and woof of bonds offering their patterns, and of mortars showing their interlacing lines of color, with which to weave the fitting garments of habitation for man.

Design in brickwork is based on an accurate knowledge of the mechanical processes of the bond. **Bond** may be defined as the method by which each brick in the wall is so placed that the entire wall, by the overlapping of the individual bricks upon each other forms one solid mass throughout its length and breadth. The bricks laid with the length of the wall, or the stretchers as they are called, secure by their overlap longitudinal bonding strength, while those laid across the width of the wall, or the headers, bond the wall transversely.

As a pure running bond, or one made up entirely of stretchers, provides only for longitudinal strength, we may be justified in saying that all structurally sound brickwork is based on either one of two methods of bonding, both of which systematically include headers with the stretchers throughout the courses. The first is known as English bond, and consists of alternating courses of headers and stretchers; the second is the Flemish bond, consisting of alternating headers and stretchers in every course, so arranged that the headers and stretchers in every other course, respectively, appear in vertical lines. All ornamental bonds are simply variations of these two fundamental forms.

It is essential, however, that the designer of ornamental brickwork should be cautioned not to confuse bond and pattern. Bond refers primarily to the arrangement of the bricks as they overlap each other from course to course. It is true, bond may be frequently used to make various patterns by this arrangement; but, in the strict sense of the term, pattern refers to the change, or the varied arrangement, of the brick texture or color used in the facing; so that in this way it may be possible to secure many patterns in identically the same bond. Pattern may also be produced by the handling of the mortar joint, or by the projection or recession of certain bricks from the plane of the wall—a form of pattern used especially in the Moorish and Spanish brickwork.

Running or stretcher bond (diagram 1) consists entirely of stretchers overlapping each other one half brick, that is, breaking joint evenly, with the vertical joints in alternate courses forming perpendicular lines. Obviously lacking inherent transverse strength, this bond is suitable for use in wall facing only, which must be tied to the backing by some artificial means. The questionable practice of using metal wall ties and the method of clipping the interior corners of the facing brick to permit the insertion of diagonal headers into the backing are illustrated in diagram 2; so also is the occasional use of a bonding brick, made of double width for this special purpose. To remedy the transverse weakness of this bond, a header—sometimes a Flemish—course is introduced at regular intervals, generally every sixth or eighth course, resulting in what is known as common bond (diagram 3 shown with three intervening courses), which affords a perfectly satisfactory bonding strength in the wall transversely as well as longitudinally. Another form of running bond is given in diagram 4. Here the stretchers overlap only a quarter brick, or are crossed one-half instead of being wholly crossed as in diagram 1. This bond is very rarely used for any large surface, but frequently occurs in two or three courses separated by a Flemish or a header course, approaching in its nature the common bond.

Diagram 5 shows a running header bond worked by the brick texture or color as a zigzag. In diagram 6 we have headers laid without any bond at all in vertical lines, producing a reticulated appearance and forming what is known as checker-board bond. Although it is sometimes used in wall surfaces, it is merely ornamental and does not strictly come under the definition of bond. It should properly be used only in panels or contained areas.

English bond (diagram 7) already mentioned as one of the two basic methods of bonding, consists of alternating courses of headers and stretchers, with headers centered on the stretchers which lie in vertical lines. The tinting of the diagram shows two possible patterns which may be obtained by change in color or texture of the brick. English bond presents serious practical difficulties in case two headers with the mortar joint, as may frequently happen, occupy a greater space than the length of the stretcher, thus making it exceedingly difficult to secure the desired alignment in the vertical joints.

English cross bond (diagram 8) referred to by some builders as Dutch or Dutch cross bond, is a modification of English bond in which the stretchers are crossed; that is, break joint evenly in the successive stretcher courses. The same practical difficulty applies to this as to English bond. Diagrams 7 and 8 are drawn so as to show two headers with the joint as being exactly equal in length to the stretcher. Diagram 8 shows two pattern arrangements which may be made

---

* By the kind co-operation of The Hydraulic-Press Brick Company, St. Louis, Mo.

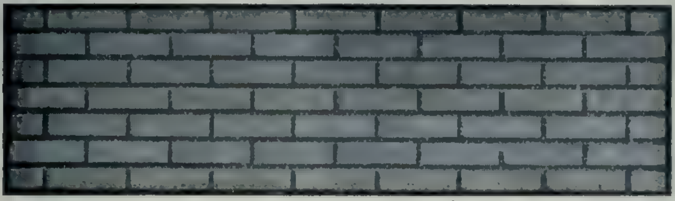


Diagram 1.

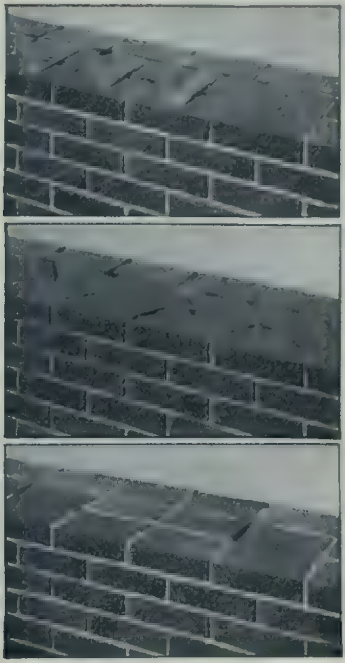


Diagram 2.

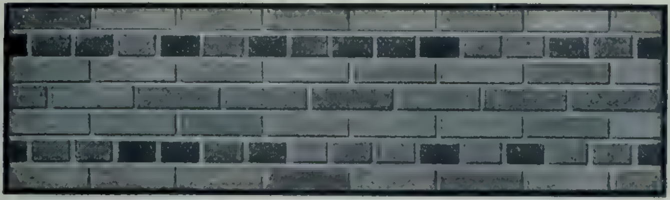


Diagram 3.

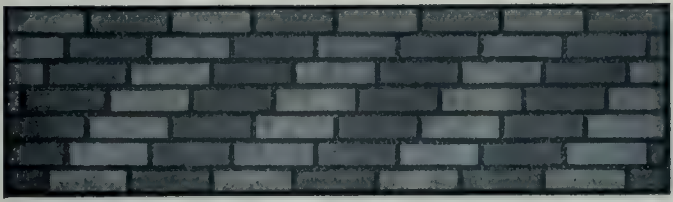


Diagram 4.

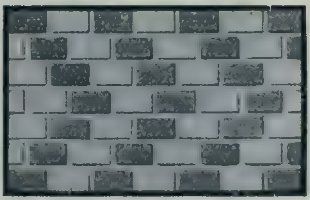


Diagram 5.

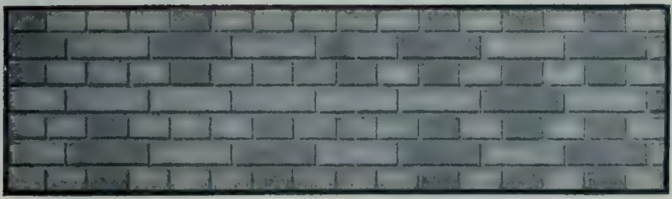


Diagram 7.

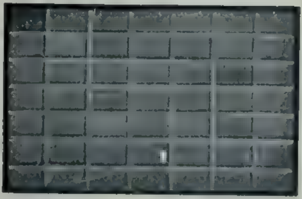


Diagram 6.

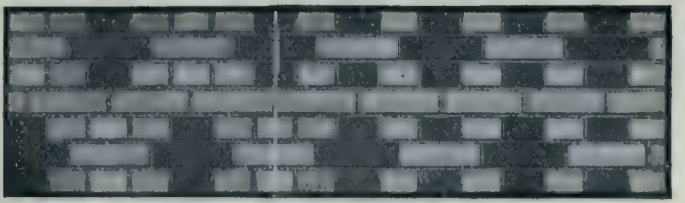


Diagram 8.

The Artistic Possibilities of Bonds and Mortars in Brickwork.

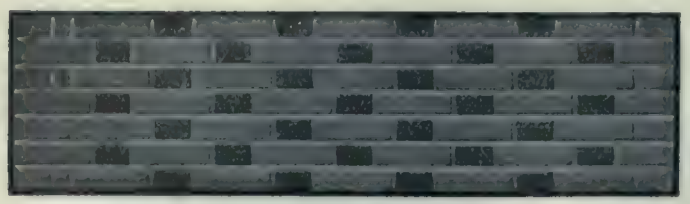


Diagram 9.

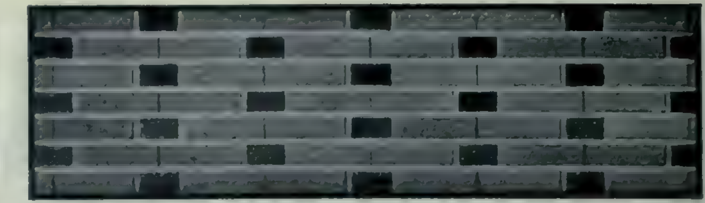


Diagram 10.

in English cross bond, dependent upon handling color or texture.

Flemish bond (diagram 9) already mentioned as the second basic method of bonding, consists of alternating headers and stretchers in all the courses of the wall, and these are known as Flemish courses. There are two legitimate methods of starting the corner in this bond, both of which are frequently used on the same work. The left end of the diagram shows the use of a quarter-brick, or "queen" closer, known as the "clip." The right end shows the use of the three-quarter brick, or "king" closer. There should be no variation in color, however, between the clip as shown on the left-hand edge and the general wall color of the course. Pattern in this bond should be made only by the headers. The closer at the corners should never be included as part of the pattern. It should be stated in passing that the brick designer must exercise great care in the use of his quarter-brick closer or clip in beginning or ending his courses at corners or edges of openings. He may without scruple begin or end his course with a three-quarter brick if necessary, but in case the clip is needed to complete the bond, it should never, except under the most pressing necessity of pattern requirements, be permitted to take the corner. Its best position is next the corner brick, as seen in the left-hand edge of the diagram.

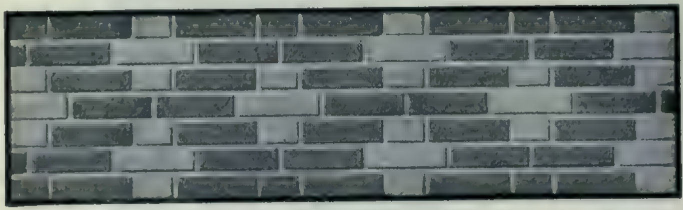


Diagram 11.

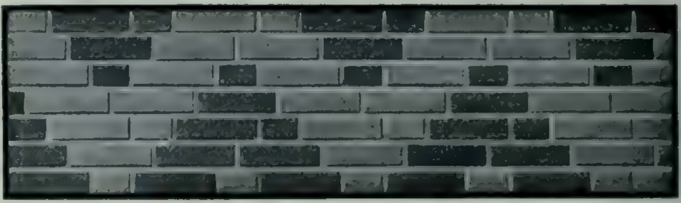


Diagram 12.

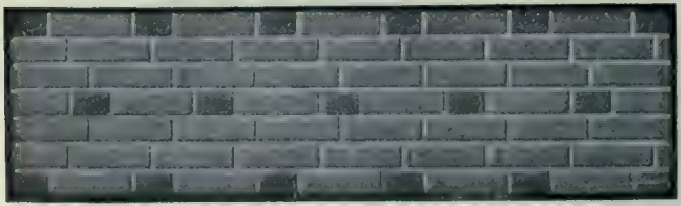


Diagram 13.

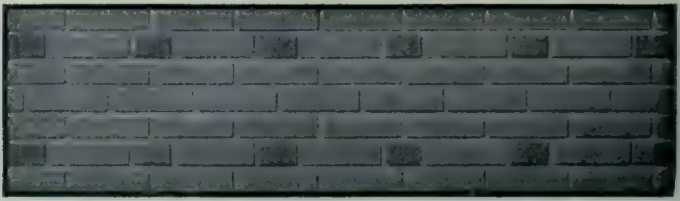


Diagram 14.

Flemish bond may be modified by doubling the stretchers in every course (diagram 10) and centering the headers over the stretcher joints, which are always concealed or "blind"—in this particular alone differing from a double-stretcher garden wall bond (see under diagram 16).

Flemish bond with its variations is the basis of most pattern bond, which largely depends upon crossing the simple Flemish bond by first introducing variously crossed stretcher courses between the Flemish courses and then shifting the Flemish header in one of several different ways, or allowing it to remain in a vertical line.

Thus in diagram 11 we have the simplest form of Flemish cross bond which consists of alternating Flemish and stretcher courses with the headers in vertical lines and the stretcher courses crossed. In diagram 12 we have the same arrangement of crossed stretcher crosses, but the Flemish header departs from

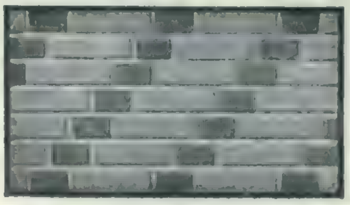


Diagram 15.

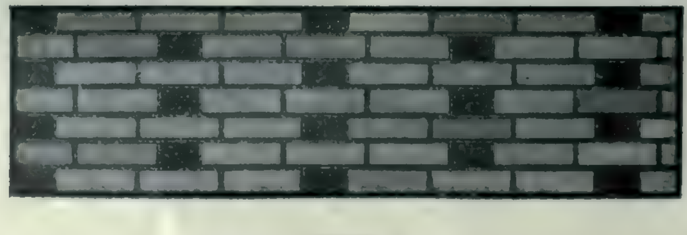


Diagram 16.

the vertical line by being shifted back and forth its width. This bond is the beginning of all diagonal pattern bonds, which owe their variation chiefly to the number and treatment of intervening stretcher courses, and to the way in which the header is shifted. In diagram 13 a Flemish course alternates with two stretcher courses which have an overlap of a quarter brick and reverse the diagonal direction of their vertical joints after every Flemish course, while the header is shifted back and forth three-quarters of a brick.

Diagram 14 represents a bond in which Flemish courses alternate with groups of three stretcher courses. This is a very satisfactory bond for average brickwork, as the headers are frequent enough to tie sufficiently the facing to the backing brick, and the work can easily be laid out so as to fit average building conditions without serious trouble (see under diagram 4 and diagram 3). Diagram 15 shows a Flemish spiral bond, having the Flemish courses laid out so that the headers break joint over each other and form diagonal bands on the face of the wall—a bond that is frequently used for stair-towers and chimneys.

In diagram 16 we have garden wall bond, which was originally used in eight-inch garden walls. Its value lies in its longitudinal strength, with sufficient transverse bonding secured by a symmetrical placing of the headers. By this arrangement a wall is laid in which both faces present a like bond surface. The diagram shows the original form of this bond, consisting properly of three stretchers alternating with a header in each course, although it is sometimes laid with two stretchers and a header—then designated as double-stretcher garden wall bond—in which case it forms the basis of double-stretcher Flemish bond, as given in diagram 10. Garden wall bond may also be laid with four or even five stretchers between the header.

Diagram 17 is a representation of garden wall cross bond, which consists of garden wall courses alternating with stretcher courses crossed. One form of pattern frequently used in this bond is indicated.

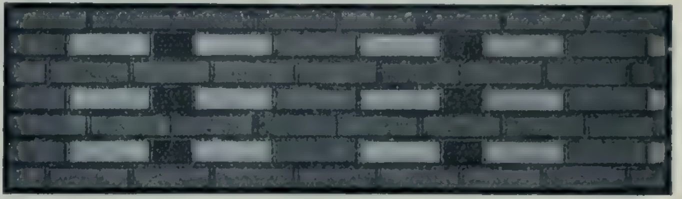


Diagram 17.

Bond Pattern Units

Diagram 18 represents the various units upon which diagonal bonds are based. Beginning with unit I, which is composed of a stretcher with a header centered above and below it, each succeeding unit is formed by extending every course of the preceding unit the width of a header, always centering the courses on the middle course regarded as the horizon-

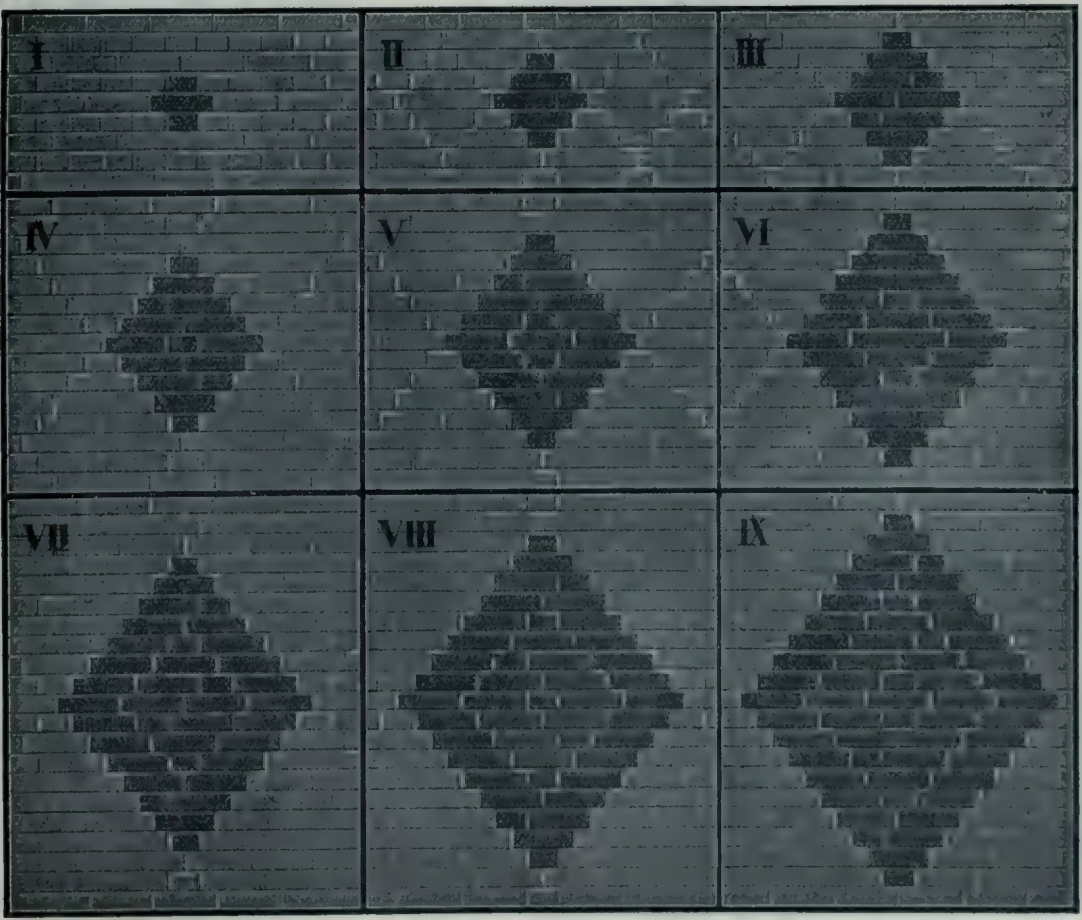


Diagram 18.

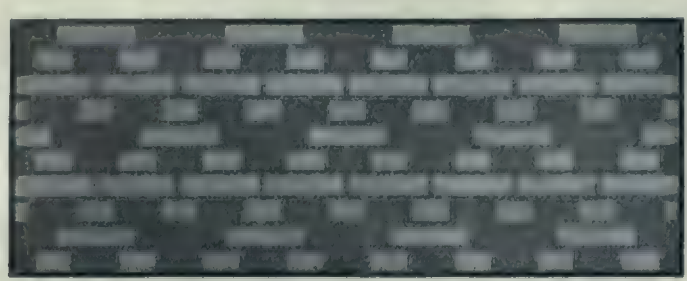


Diagram 19.

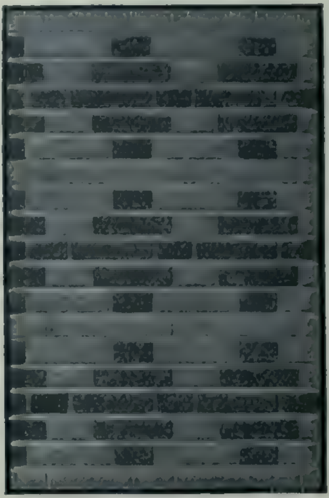


Diagram 22.

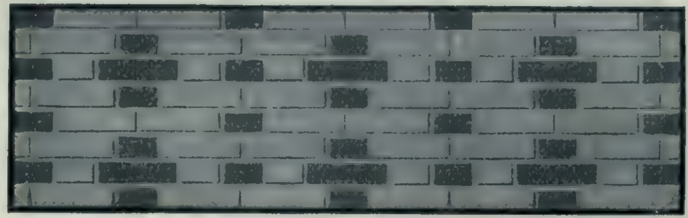


Diagram 20.

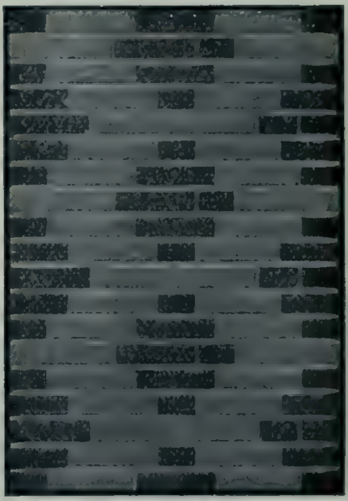


Diagram 23.

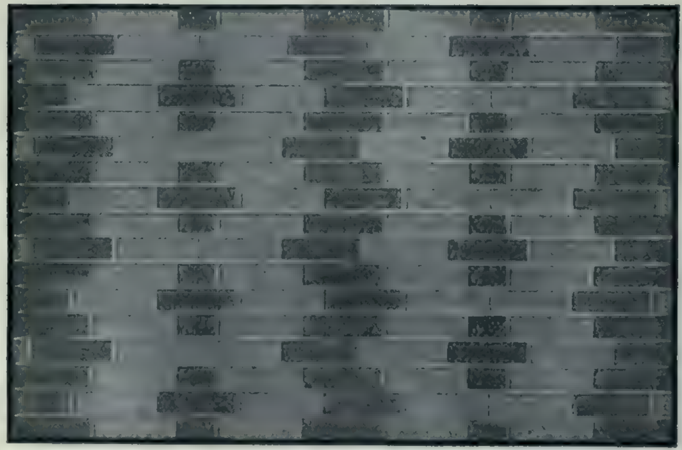


Diagram 21.

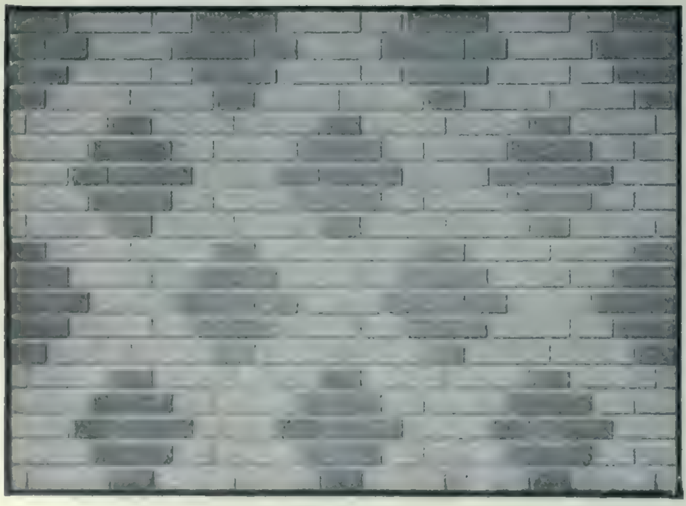


Diagram 24.

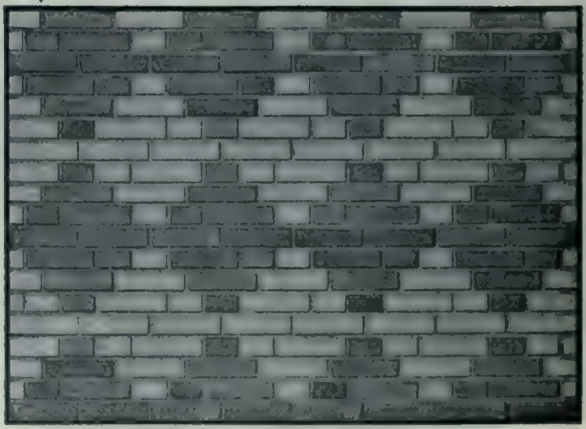


Diagram 25.

The Artistic Possibilities of Bonds and Mortars in Brickwork.

tal axis of the unit, and terminating the whole above and below by a header.

As a result the units, however far they may be carried out, always present exact mathematical proportions and bear a definite relation to each other. The serial number of any particular unit may at once be known by subtracting one from its number of courses and dividing by two; or, more simply, by counting the number of courses either above or below the horizontal axis. Conversely, the number of courses in any given unit may be known by doubling its serial number and adding one. Thus if we discovered in a brick wall a unit of nineteen courses, nine courses on either side of the horizontal axis, we should know that it was unit IX; or if we wished to use unit IX, we should always be obliged to have space for nineteen courses; and so on.

It is interesting to note further that the units may also be recognized by their horizontal axes, which in odd-numbered units are always composed entirely of stretchers, while in even-numbered units they always carry one, and only one, header, set as near their center as possible. The serial number of an even-numbered unit is double the number of stretchers in its axis, while that of an odd-numbered unit is one less than double the number of its axial stretchers. Thus if we see a unit with a horizontal axis of four stretchers only, we may be sure that it is odd-numbered unit VII; but if it have four stretchers and a header, we know that it is the even-numbered unit VIII.

With unit IV there begin to appear units within units. While the header, crossed by vertical stretcher joints, which appears at the center of Unit IV is not strictly a unit in our sense of the term, it is nevertheless the primary unit of all, as the smallest normal element in brickwork. Unit I clearly comes to view as the center of unit V; unit II appears in VI; unit III in VII; and so on. It is by the treatment of these units, each of which in itself is a bond pattern, that various patterns may be worked out on the surface of the wall by the proper handling of the color tones and textures in the brick, or of the mortar joints.

The units may be made to join, or "butt," each other vertically and horizontally; or they may be separated by introducing between them one or more courses above and below, or variously arranged rows of brick in a general vertical direction on the side, as may be seen in the following diagrams. When separated, the units are said to be surrounded by horizontal and vertical borders. And much of the artistic value of the pattern will depend upon the skill and taste with which these borders are worked out.

The designer in brickwork is urged to remember that the use of pattern bonds requires him to pay the strictest and most thoughtful attention to the beginning and ending of the pattern, either at the bottom or top of the structure, or on piers as they occur separately or between windows. He must first decide on a unit which is suitable to the size of the panel to be covered and then exactly center it upon the panel, so that his pattern may end in a symmetrical manner, both laterally and vertically. In order to secure vertical symmetry the panel must always have an odd number of courses, that is, an even number on each side of the median line.

Bond Units in Pattern

The accompanying diagrams offer a few suggestions of the way to handle the units, and to treat the color tons and textures of the brick in designing patterns.

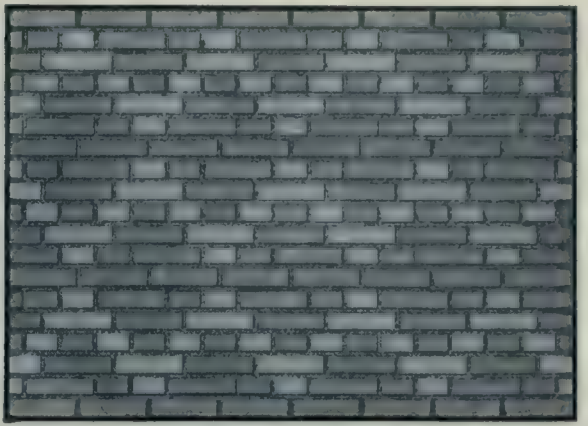


Diagram 26.

Diagrams 19, 20 and 21 are readily seen to be examples of unit I, which, if brought out in the design, always presents the appearance of a St. George's or Greek cross. Diagram 19 is, in bond, identical with diagram 8, or English cross bond, and differs from it only by the treatment of the colors in the brick, so arranged as to veil the definition of the units. By comparing the two, it will be seen what different patterns can be woven into the same bond. Diagram 20 is a sort of garden wall bond with the units and certain headers in vertical lines brought out by heightened tones in the color or texture of the brick. In diagram 21, consisting of alternating crossed stretcher and garden wall courses, the unit is also highly accentuated and surrounded by a vertical and horizontal border, but is accompanied by a vertical zigzag of stretchers instead of a vertical line of headers.

In diagrams 22, 23 and 24 are shown varied treatments of unit II. Diagram 22, which is a modification of Flemish bond as seen in diagram 9, presents a wall surface composed entirely of these units completely dove-tailed. Here we have an excellent illustration of the distinction between bond units, as such, and pattern. The bond inevitably works out the bond units, and these may be of uniform color or texture throughout the wall; or, as here, brought out by color or texture treatment into distinct pattern units, which butt horizontally and are separated vertically by a header-

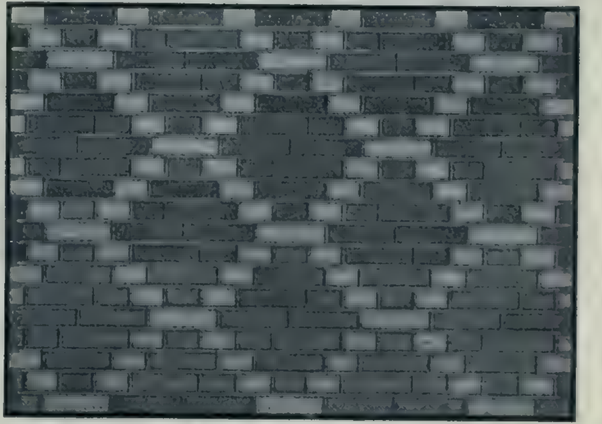


Diagram 27.

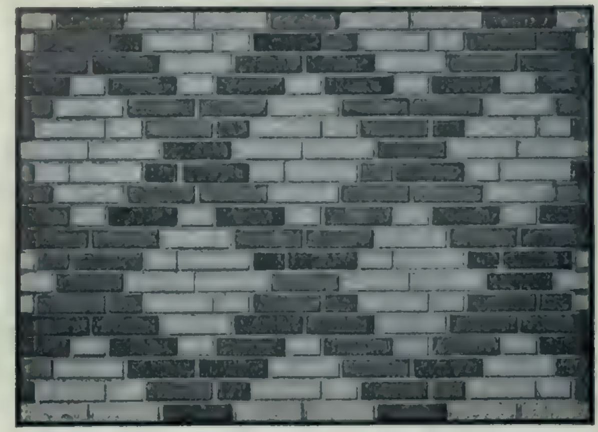


Diagram 28.

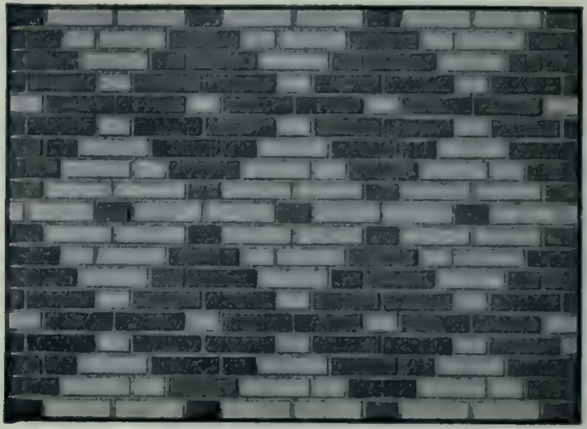


Diagram 29.

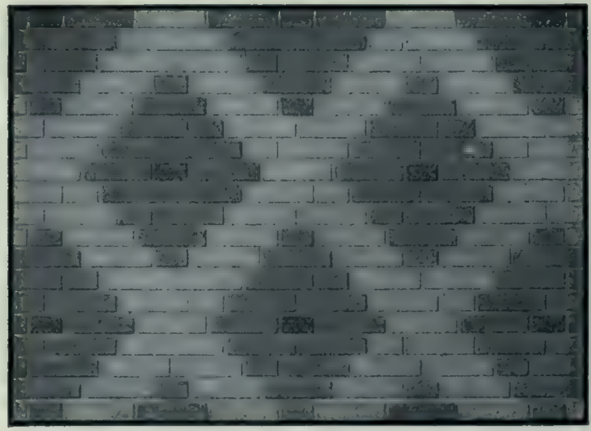


Diagram 30.

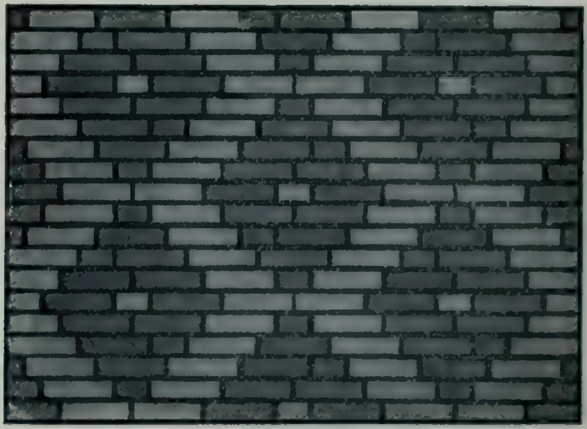


Diagram 31.

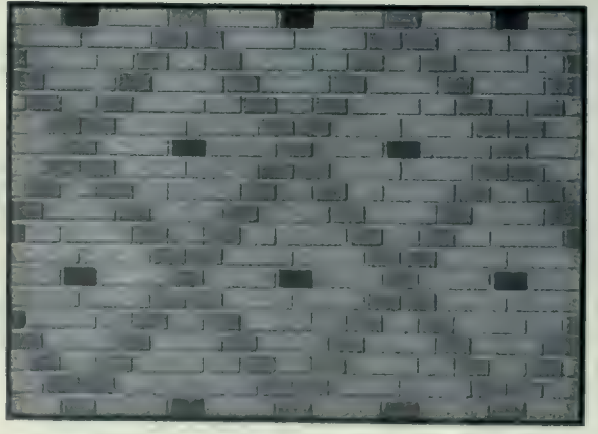


Diagram 32.

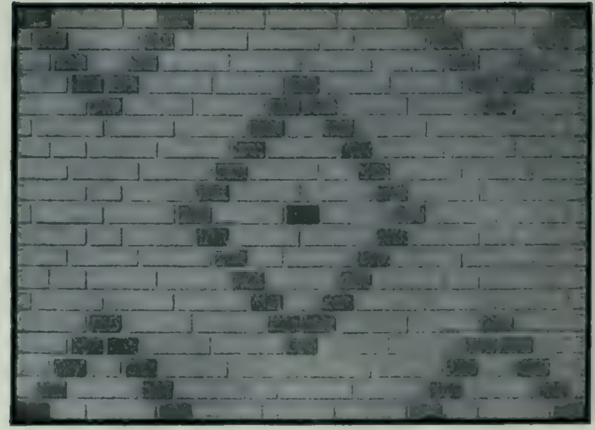


Diagram 33.

The Artistic Possibilities of Bonds and Mortars in Brickwork.

stretcher border. Diagram 23 is a garden wall bond with the units in vertical lines; while diagram 24 is a double-stretcher garden wall bond with the units in diagonal lines. In both there is a horizontal and vertical stretcher border about the units.

Diagrams 25, 26, 27 and 28 present a variety of design based on unit III. Diagram 25 shows a bond of stretcher courses, crossed, alternating with courses of two headers and a stretcher, in which the bond and pattern units have the same dovetailed arrangement as in diagram 22. Diagram 26 is the same bond as the preceding except that every sixth course is entirely of headers, flanked by uncrossed stretchers. Here, as before, the pattern units butt horizontally but, instead of lying vertically separated by a stretcher course, are set in dovetail fashion and separated vertically by a zigzag line of stretchers and headers.

Diagram 27 presents a very mixed bond in which Flemish and stretcher courses are intermingled regularly with courses of alternating stretchers and four-header groups. The units, deeply dovetailed, are separated horizontally by header and vertically by stretcher borders; and it is interesting to note that the stretcher courses are so set as to form the axial line of one horizontal row of units while serving as the horizontal borders of the next row of units. The pattern in diagram 28, worked on a bond of alternating Flemish courses and stretcher courses, crossed, shows the units separated by vertical and horizontal stretcher borders that sweep in great interlaced diagonal bands up and down the surface of the wall.

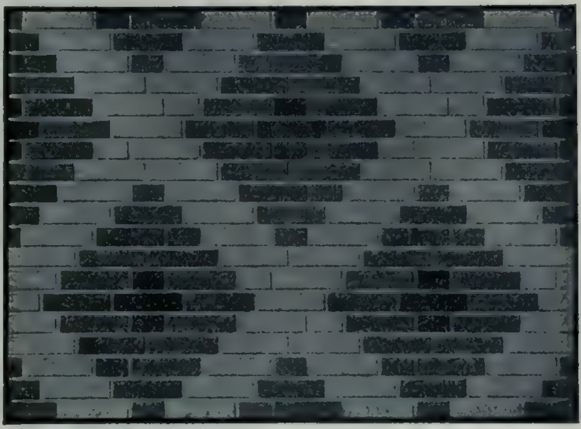


Diagram 34.

Nothing could show better than this diagram how really simple is the secret of working out these seemingly complex figures. Once having crossed the alternating stretcher courses, that is, shifted them half a brick each time, it is only a matter of attending to the method of shifting the Flemish courses by watching the movement of the header. Beginning for convenience with the fourth course, because in this diagram the first full unit begins there, it is seen that the header shifts its own width three times to the right and then three times to the left, and so on up the entire wall. It will also be seen that the headers rest alternately on stretchers and stretcher cross-joints, and that, with all the shifting, they never depart from this original position.

Digrams 29, 30, 31, 32 and 33 furnish beautiful examples of unit IV. Diagram 29 is a double-stretcher garden wall bond showing the same arrangement of units as in diagram 25. And yet aside from the difference in the size of the units employed, there is a striking difference in their appearance when viewed in their relation to the texture of the whole wall surface. In the first instance, the smaller units, with but one distinction of color, are woven together into a compact wall texture. In the second, the larger units, which would be too heavy if thus left solid masses of color, are enlivened by luminous points in their centers, the dark spots giving as much life to the light units as the light spots do to the dark units. Thus the wall is interlaced as a beautiful fabric and presents the appearance of lightness and vivacity.

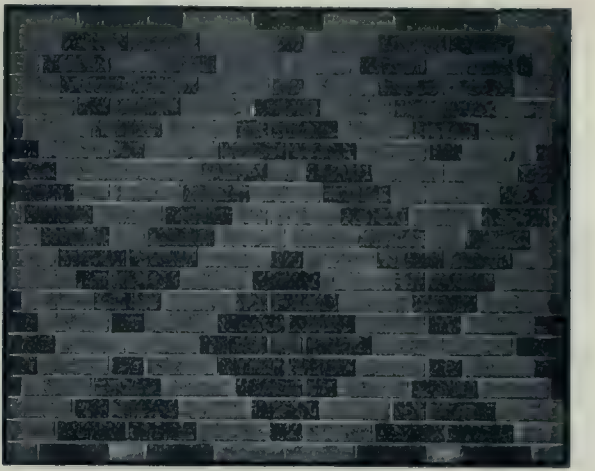


Diagram 35.

Diagram 30 shows a garden wall bond with the unit set in dovetailed fashion but surrounded by a stretcher border.

Diagram 31, a four-stretcher garden wall bond, has the units more deeply dovetailed than they are in diagram 30, resulting in their being thrust apart horizontally by two stretchers instead of one. They also show a horizontal and vertical stretcher border, and are much enhanced in value by the bright spot in their centers. Diagram 32, a very mixed bond, shows the

Diagram 36.

dovetailed units separated by header borders which form interlacing diagonal lines on the surface of the wall; while diagram 33, also a very mixed bond, presents in like manner the units surrounded by headers but widely separated by double-stretcher borders. By a little study, both the diagrams last named may be seen as presenting unit VI—merely outlined by the headers—enclosing unit IV. In the one case, the units overlap both vertically and horizontally; in the other, they stand out quite alone.

Diagram 34, a mixed bond, shows unit V. Here the units, holding in their centers Unit I, are set in exactly diagonal lines and bordered vertically and horizontally by stretchers; while diagram 35 presents a four-stretcher garden wall bond on which is designed unit VIII, containing unit IV, distinguished from each other by color tone. The dovetailed units are separated by a horizontally zigzag line of stretchers.

Diagram 36, on the left side, worked on a bond of alternating double-stretcher garden wall and stretcher courses, crossed, presents an appearance similar to that of diagram 35, but does so by the use of unit IX enclosing unit V, which in turn bears at its center unit I, all of them brought out by a difference in color. On the right side, by a change of bond, the contained unit V is made up of unit I surrounded by like units.

In leaving this subject, it may be well to observe that the choice of a bond unit and the way in which such bond units are to be distributed on the wall surface, as well as the manner of treating them in color or texture, are matters open to the widest divergence of individual tastes. One designer may be inclined to strong contrasts, while another may treat them with the utmost reserve. But in every case the one aim should be to weave the fabric of the wall in such a way as to make evident its fitness both to the nature of the structure and to its surroundings, natural and artificial.

The subject of bond, however, can hardly be dismissed without a word, and a diagram or two, on paving or panelling bonds. They may be illustrated in a few typical forms.

Diagrams A and B show a herring-bone pattern which may be laid with the brick flat or on edge. Diagrams C and D represent a basket pattern in its two forms, that is, laid flat or on edge. Diagram E is a basket pattern laid flat separated by borders laid on edge; while diagram F shows a basket pattern laid on the edge separated by borders on the flat.

A Suggestion

These bonds and patterns here illustrated are meant to serve as helpful suggestions to the designer in brickwork; his ingenuity and taste may lead to any number of possibilities along the same line. While the methods of bonding, when once a bond is chosen, are strictly governed by mechanical rules, the pattern schemes, a few of which have been presented here, are a matter for the individual taste of the architect or the prospective builder. These diagrams are by no means intended to dictate what may or may not be the true

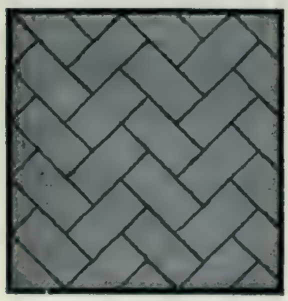


Diagram A.

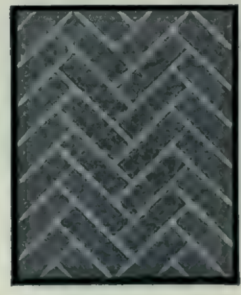


Diagram B.

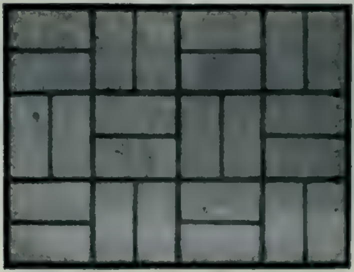


Diagram C.

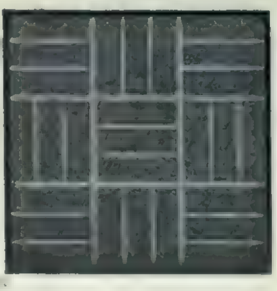


Diagram D.

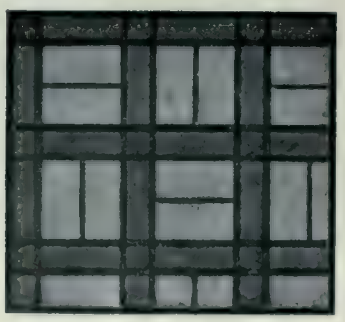


Diagram E.

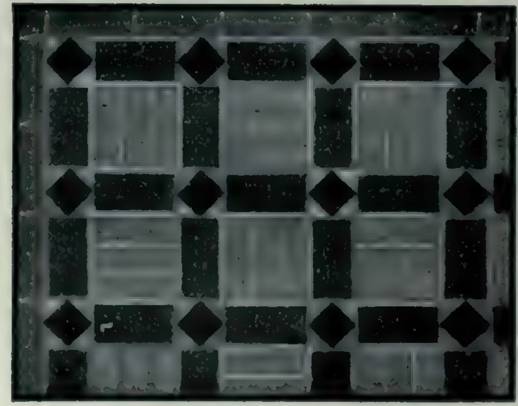


Diagram F.

The Artistic Possibilities in Bonds and Mortar Brickwork values of color tones in any given bond, what the blendings of light and shade or the contrasts of color and texture in brickwork, but merely as suggestive hints for pattern design.

At the same time, an underlying principle is involved in what has been thus suggestively presented. It will be readily understood that the smaller units, which are worked into patterns of finer texture and quieter shadings, are more appropriate for wall expanses of limited area, while the bolder outlines and heightened contrasts of the larger figures are more suitable for large sweeping wall surfaces.

(The concluding portion of this article—Part II—will be published in our next issue.)

A Symposium on Heating and Ventilation and Some Mechanical Errors of Installation

By Thomas Morrine, M.E.

THERE is, perhaps, no branch of engineering which comes within the scope of the architect's responsibilities that has been so much abused, hampered and trifled with as that of heating in its various forms of radiation, ventilation and domestic hot water; at the same time there is none that is so simple and assured of satisfactory results as this particular portion of a structure when properly designed and installed. There is absolutely no mystery, superstition or difficulty about the whole problem if one would consider for a moment the natural laws of gravity and the effect of heat.

Heat or heat losses are the cause of action in all heat radiating apparatus, be the medium steam, water or air. If this heat action is combated or thwarted by an apparatus that is designed contrary to, or preventing the natural effect of the laws of gravitation, without the assistance of some mechanical device to overcome this defect, there will be trouble, and unsatisfactory results will occur.

You will hear people, who are not correctly informed in these principles, talk of forcing the circulation of hot water or air in this way or that way; such remarks, belief and suggestions are ridiculously wrong. There is no such thing as forcing the circulation of any of these elements, in any direction, in a piping system that is arranged contrary to the laws of gravity unless, as I said before, it is assisted by some mechanical device in the way of a pump, fan, air, steam or water blast, or similar arrangement that will have to be maintained by power, especially brought in or connected for the purpose.

As steam at low pressure is the most common agent, and as direct radiating systems are the most popular for heating purposes, we will take that branch up first as a matter of discussion.

Steam at low pressure requires piping of a large size (not steam table) and so arranged that the condensed water and steam may travel in the same direction, as far as possible and practical, and the mains so arranged that they will be comparatively dry at all times, and of such dimensions that the difference in pressure between the source of supply and the point of return will be so small that a water head of a few inches will overcome it; that is, this condition is absolutely necessary for a successful gravity return system such as is commonly used in dwellings, apartments, small hotels and kindred buildings that do not have a complete steam power plant using high pressure steam.

The velocities through the main should not exceed 20 feet, and at the outside 25 feet per second for the steam, and for water a maximum of 6 to 8 feet per second will give satisfactory results. If these conditions are changed and the velocities increased by the use of smaller pipes, you may expect trouble, and the trouble will be with you as long as you live. There is no escaping the result in a conflict with the law of gravity, no more than there is in a conflict with other laws of nature. New discoveries are being made every day, new schemes devised, new apparatus invented, promoted and foisted upon the people as a cure-all and the last word in all these troubles. If you purchase the arrangement you are assured that you will be forever freed from the annoyances of a noisy heating system and the constant nagging of dissatisfied clients because of the unsatisfactory condition of the piping.

By adopting some of these modern mechanical schemes of improved valves, etc., some relief may result, and it often does, but not any more from the adoption of the improved apparatus than from the opportunity this change affords a good practical heating engineer or steam fitter to change the system in general, so that results would very often be as satisfactory without the improvement as with it; but such opportunity would never have occurred had not the change been imposed by the placing of the improved apparatus that receives a credit to which it only is indirectly entitled. So much for steam.

In the matter of hot water for radiation or for a domestic hot water sanitary service, the circulation is usually controlled by the difference of density due to the heat infused into the water by conduction, convection or radiation. The source of heat matters little as long as the temperatures are acquired. The circulation through a system, unless accelerated by mechanical means, depends entirely upon the law of gravitation, and the velocity of motion is determined by the law of falling bodies, counteracted by the friction in the piping, bends, valves, angles, etc.

Now, it may surprise some of you to know that the small difference by expansion between the heights of a column of water at, we will say, 180 degrees and at 160 degrees Fahrenheit, a difference of 20 degrees, is the sole and only influence that causes hot water to circulate in a gravity system. You will realize, therefore, the importance of having the piping of such a size and arranged in such a manner as to minimize the resistance to the flow of water under these influences so that you may reap the full benefit of the coal or other fuel used for generating the heat.

Heating systems and the distribution of steam and hot water for heating purposes in general have so far escaped the rigid rules laid down by the local law makers for sanitary systems, because the failure of the former does not so materially affect the public health as does the latter, but I have often felt that it would be wise on the part of the community, as a protection to the owner and to the renting population, to prescribe that established rules for the placing of a heating apparatus should be as carefully protected by a simple law as are the sanitary rules that we are now working under.

When a faulty system is once installed and the building enclosed and finished, it is a hard problem to change or to rectify the defects without a serious disturbance to the structure and occupants of the building, and a great additional cost to the owner. These difficulties have brought about a serious state of affairs since the institution of street service, as I know from personal experience, having been called in on several occasions to rectify these difficulties, that, in the imagination of the owner, are brought about by connecting steam with the street; and while the street service has its shortcomings, yet it often is unjustly condemned because of inherent defects in the heating systems and in the general arrangement of the plant before the street connections are made. These annoyances have been the cause of a great deal of dissatisfaction and bickering between the street service corporations and the property owners in many instances.

Architects, as a rule, are prone to conceal piping, very often to the detriment of the system, not that it is necessary to expose piping if sufficient space is allowed for the pipe and the necessary insulation to prevent unnecessary radiation and comply with the underwriters' rules.

Again, others are not satisfied unless a forest of pipes and risers are installed in a system, for no useful purpose whatever, except of causing an excessive fuel consumption and corresponding overhead loss to the owner for all time. They seem to lose sight of the fact that these conditions remain forever, that there is absolutely no relief except a complete remodelling of the whole system, which very often is next to impossible.

The distribution of air in buildings, particularly in wooden structures, brings about, as a rule, a warm contest between the architect and the engineer, because of the difference between the size of ducts necessary for efficient service, and the size existing in the imagination of people who do not go into the merits of the system in the proper form or frame of mind. An architect would not think of reducing the size of a sanitary main or of a water pipe for a certain specified service, yet he will wrangle with you for an hour to get a few inches off a hot-air duct or spread it out in pancake form, which makes it next to impossible to get any air through it at all, to say nothing of the generous volume that is actually required for a satisfactory ventilation or indirect heating.

It is a well-known fact that a square chimney is only useful to the extent of the largest circle that may be inscribed within the square; the corners are useless owing to the excess friction, but the peculiar condition of our construction of brick and mortar, the square or rectangular chimney is more conveniently constructed and conforms better to architectural lines than the circle where the chimney is built into the wall and made part of the structure; yet we are compelled sometimes to make ventilating ducts of a square or rectangular form that increases the skin friction to such an extent that, although of the same sectional area, they are practically useless for chimneys or air ducts, and the purpose for which they are originally intended is completely lost sight of or destroyed.

If it is necessary to pass 1,500 cubic feet of air through a duct per minute at a velocity of not to exceed 1,500 feet (which should be the maximum for any air circulating scheme), that duct should be circular and of one square foot in area or square, or perhaps rectangular, but the least width should never be less than two-thirds the side of the square necessary for the area required, because as soon as you begin to increase the width and diminish the depth you are increasing the skin friction of the duct to an injurious and sometimes prohibitive extent. Who has not seen an 8-inch diameter duct flattened out and squeezed into a 2½-inch thick by 22-inch space in a framed partition, and the contractor condemned because he could not deliver the maximum amount of heat and air through the register connected to a duct distorted in this manner?

I am not calling your attention to these facts in a spirit of fault-finding or of egotism on the part of the engineer; I am simply mentioning them to expose an objectionable and ill-founded practice, and to emphasize the point that in the correct make up of a building the heating and ventilating portion of the equipment stands on a par in importance with its other details.

The Value of Cost Data in Highway Engineering

By Major W. W. Crosby*

THE mention of cost in connection with any discussion of highway work seems almost inevitable, and its analysis or even its statement always arouses interest and, frequently, discussion. Cost is the ready yardstick of the world for measuring the worth of many things, including the results of road and street work. Often it is not the only one that can and should be used, but, generally speaking, it is the one most frequently applied. The importance of its standardization may hence be readily inferred. In the engineering prescription toward a result, almost the first question after the possibilities of the solution of the problems have been indicated is, "What will it cost?" If variety in the solution is practicable, a comparison of the costs becomes necessary in order to assist if not to determine the wise choice. The recording and compilation of cost figures regarding work in progress is the most practical way, in these days of enormous operations, for testing the efficiency of the organization and individuals employed thereon, and for enabling the proper management of the work. In small operations, where the details are not beyond the capacity of the individual in charge, personal knowledge and ability might be successfully depended upon to produce economical results and proper work; but as soon as the operation grows in size beyond the capacity of the individual in charge to control the details, inefficiency is bound to result unless proper records of cost are promptly presented.

The desiderata for cost data may be said to be comprehensiveness, clearness, conciseness, low expense of keeping, ease of keeping by unskilled employees, readiness of and clearness in compilations, regularity of compilation, and periodicity of publication.

Of course, if vouchers containing sufficient detail concerning each expenditure are preserved and filed, it may be said that cost data is being accumulated in a way, but few will pretend that such a course is sufficient. However, every record of expenditure should be so comprehensive on its face as fully to explain the payment made. Clearness should mean intelligibility without the aid of personal explanation from the responsible party in the case of a voucher, and, in the case of accounts, the reasons for segregation of different vouchers into one or more accounts should always be clearly logical or apparent from the established rules provided.

---

*Chief Engineer, Maryland Geological and Economic Survey.

It may be said, without fear of contradiction, that the large majority of costs yet published, either of details of road work or of organizations for road work, are of no scientific value, nor are they of any appreciable value, except to members of the respective organizations themselves, and no fair comparisons between the work of different organizations, such as the various state highway departments, are possible in spite of the voluminous publications available.

It will be readily seen that if several states or organizations engaged in similar work kept and published their expenses along similar lines it would easily be possible to compare the relative efficiency of each, even though many local conditions were dissimilar, and allowance had to be made therefor. A type of organization could thus be tested. Types of construction could be proved. Even corruption or inefficiency could be detected, and real defects of materials or methods could be observed. With all these advantages would also come that of presenting to the taxpayers, in understandable form, a concise report as to the expenditure from the public funds so that criticism could be made effective when good, and disarmed when merely captious, unreasonable, or malicious.

In establishing any system for recording and compiling cost data, while the outline may proceed from the top down, the actual work must be begun at the bottom and proceed upward. Hence consideration of the foundation in this matter, as in all highway work, is necessary. No system can be successful which relies on an impractical foundation—that is, the compilations and accounts must be settled with a clear view as to the possibility of obtaining the data on which they are to rest. For instance, unless expert timekeepers are to be employed regularly, it is useless to provide too much sub-division of accounts. In ordinary maintenance work by a patrol-man all that can be expected on this line from the patrol-men best fitted for the physical work is that they will be able to report separately the expense for earthwork culverts (including shoulders), bridges and drains and surfacing, with occasional special reports, from a special inspector perhaps, of such special work as the painting of the edges of the surfacing or the taking up and relaying of a pipe. It may even turn out to be impracticable for the maintenance work to be separated between two differently contracted-for sections of the same road.

Further, in proceeding upward from the collection of facts regarding costs toward the final compilation, the accounting and the intermediate compilations should be so arranged as to fit progressively into the final scheme without the necessity for retracing at any time the steps taken up to that point.

It is true, as first stated, that "cost" is not the only measure of value of work done, though it is a very common one. But other criteria should not be neglected or allowed to slip into "innocuous desuetude." Engineers have been criticised as lacking breadth, and as being too materialistic. It behoves us, therefore, to keep our eyes open to the criteria other than "first cost," or even "long-run cost," in passing judgment on work done, important as the cost factor may seem to be.

Interesting Application of Cableways at Grand Mere

An interesting application of cableways for both excavation and construction is shown in the illustration of the work now under way at Grand Mere, Que., for the Laurentide Company. This project, including the dam and power house, involves the placing of 175,000 cubic yards of concrete and 110,000 cubic yards of solid rock excavation. Work began early in 1913. The cableways were erected at the beginning of the summer and good progress was made all winter, notwithstanding the severity of the weather.

The illustration shows at the right hand side of one channel of the St. Maurice River the rock and sand storage and the concrete mixing plant. At the middle of the picture is shown the island with Grand Mere rock in the foreground. The entire top of the island, which is of solid rock, with a thin overburden, will be removed in order to give sufficient spillway, and this rock is carried across the river and channel to the rock storage pile at the right. The new power house will be located at the left of the picture, changing the present mill structure, and the view shows this channel of the river unwatered by means of the cofferdam below and above proposed site of the new power house. Already a large amount of rock has been removed from the island and considerable concrete laid for the power house foundation and draft tubes.

Three Lidgerwood cableways are employed, the

Lidgerwood cableways at Grand Mere, Que.

long span being 1,653 feet, with towers at the extreme ends of the picture. This cableway takes mixed concrete to the site of the dam and power house. The intermediate span, 1,118 feet, takes rock from the island to the crusher and storage pile. The short span, 613 feet, is used for taking rock, sand and cement to the small auxiliary crusher plant on top of the present mill building from which mixer plant the concrete is discharged directly into the power house foundations and walls.

There will be a fourth cableway, 5-ton capacity, 900 ft. span, used for constructing a section of the dam to be located to the right of the picture and which will be a separate unit of construction.

The two long span cableways are each equipped with the latest Lidgerwood improved aerial dump adapted for discharging automatically at the will of the engineer, either skips or bottom dump concrete tubs, the skips being so discharged into the crusher or storage pile.

The longer span cableway taking concrete and conveying it a distance of 1,100 feet from the mixer handled 387 cubic yards in ten hours in two-yard batches. The bottom dump tubs are discharged automatically at any point along the span, going in either direction and at any elevation, either raising or lowering entirely under the control of the operator. The record mentioned was made at a distance of 1,100 feet from the hoist and operator. The concrete is placed directly into forms or deposited into hopper from which it is spouted.

Messrs. Canadian Allis-Chalmers, Limited, are exclusive agents in Canada for Lidgerwood Cableways.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

The Bowlby Sand Lime Brick Company, Limited, Milton, Ont., capitalized at $100,000, has obtained a charter.

A new central police station, estimated to cost $350,000, will be erected in Toronto, following a recent decision of the Board of Control.

Mr. R. A. Pringle, K.C., of Ottawa, has arrived at St. John, N.B., to conduct a government enquiry into the cost of the Southampton Railway.

A new building by-law is at present before the City Council of Sherbrooke, Que., providing for the creation of a Building Inspector's department.

A Fort William contracting firm, Messrs. Flanagan & Murphy, have secured the contract for the laying of water and sewer mains in Humboldt, Sask. The contract price is in the neighborhood of $100,000.

Work is in progress on the customs house which the Dominion government is erecting at Ottawa at a cost of $400,000. The concrete work on piers for foundations has been completed. The building will be five storeys high.

Announcing the taking over of the Kingston Shipbuilding Company, of London, Eng., a recent despatch from Kingston states that the company is considering the establishment of another branch of its shipbuilding activities at Fort William.

At Port Arthur, Ont., operations are to commence on the construction of a new breakwater estimated to cost $475,000. The work is to be done for the Dominion government by the Port Arthur Construction Company, Limited, whose manager is Mr. J. C. Hicks.

A number of the directors of Standard Clay Products, Limited, left Montreal last week on a visit to the firm's large new plant just completed at New Glasgow, N.S. Arrangements are being made for the rebuilding of the company's No. 2 plant which was destroyed by fire recently.

The great majority of the building permits now being issued in Montreal are for residences, there being comparatively few large buildings in course of erection. As showing the tendency, one day recently 43 permits, of the value of $250,000 were issued for residences, this being the largest number issued during any day.

It is now practically assured that the programme of Fort William's civic improvements for 1914 totalling some half million dollars, will be carried out and completed this year. The improvements are for paving and road building, and for the extension of the street railway to the industrial zones on the Islands and other outlying localities.

The Lake Superior Ship Building & Dry Dock Company has applied for an extension of time in which to commence construction of the new dry dock which is to be built at Sault Ste. Marie, Ont., at a cost of a million and a half dollars. The delay in completing the plans was caused mainly by necessary legislation.

Consequent upon a dispute with the Montreal Light, Heat & Power Company as to the annual cost of lighting certain streets from underground distribution, the civic superintendent of lighting has reported on a plan for installing a power plant for the central district. This, he estimates, will cost $172,667, with annual operating expenses of $54,100.

At St. John, N.B., work is in progress on a bridge across the Reversing Falls. The general contractors are Jos. McVey & Son, St. Stephen, N.B., and the estimated cost of the work is $325,000. Work on the superstructure will start shortly. The bridge will be 565 ft. long. It is being erected for the provincial government of New Brunswick.

Railway construction continues active in New Brunswick. In addition to the Valley Railway work has been started on the new line which is to run from Plaster Rock to Riley Brook, a distance of 28 miles, and later is to be extended to connect with the I. C. R. about half way between St. Leonard's and Campbellton, on the north shore of the Province. Four lumber milling companies have already consented to erect mills along this new line.

In addition to the big harbor improvement contract awarded the Thunder Bay Contracting Company for a sea wall at Fort William, Ont., costing $340,000, the dredging operations which were started a few days ago will equal, if not exceed, last season's expenditure, which was over $1,200,000. Five huge dredges are at work in the Kaministiquia, McKellar and Mission rivers, and three more will be added in a week or two. Fifteen or twenty tugs and thirty mud scows are employed in attending to the dredges, and a force of some 300 men are busily engaged on the work.

WESTERN CANADA

The power and development committee of Calgary has recommended that the Engineering Department of that city proceed at once to make test borings at dam site No. 4 on the Elbow River, with a view to determining whether the rock foundations and side walls are sufficient to carry it down. The cost of such borings is estimated to approach $10,000.

The Regina Red Press Brick Company has located in the Saskatchewan capital, and a plant is being erected at a cost of $75,000.

Contracts will be placed immediately for buildings estimated to cost $300,000 for the Saskatchewan Provincial University, of Saskatoon.

The ratepayers of Regina have approved a by-law providing for a site on the north side of the city for the erection of a Collegiate Institute.

The Calgary waterworks are to be extended at a cost of $250,000. The engineer in charge is Mr. A. W. Fawkes and the city clerk, Mr. J. M. Miller.

At Dauntless, Alta., operations are about to be commenced on the erection of a factory estimated to cost $750,000 for the Dominion Harvester Company.

Mr. J. A. Browne, of the Bogue and Brown Lumber Company, is erecting a four-storey hotel, 120 by 110 feet, estimated to cost $125,000, at Edmonton.

The city commissioners of Regina have invited tenders for the supplying of about 150,000 ft. of sewer pipe, ranging from 6-in. to 60-in., also for 400,000 sewer bricks.

The Winnipeg Public School Board are having plans prepared for a $200,000 shool building at the corner of Helen and Fleet Streets. The architect is Mr. J. B. Mitchell.

The Canada Cement Company expect to have their new plant at Dauntless, Alta., completed in time to supply the demand for cement which will coincide with a renewal of active building operations.

Preliminary sketches have been prepared for a new school building at Vancouver, B.C., estimated to cost $100,000. The plans are by the Superintendent of Construction for the School Board, Mr. Giles.

At Edmonton, Alta., an eight-storey addition is to be made to the Y. M. C. A. building at an estimated outlay of $500,000. Plans for the new structure are being made by Messrs. Magoon and Macdonald.

It is announced that excavation has been completed and that construction will begin soon on a seven-storey office building at Edmonton at a cost of $120,000. Messrs. Cauchon and Van Tyne have prepared the plans.

Richardson Builders, Limited, of Saskatoon, Sask., have secured the contract for the construction of a students' residence at the University of Saskatchewan, Saskatoon. The amount of the contract is about $200,000.

Messrs. Frid Lewis & Company, of Regina, are the contractors for a new police station to be erected in that city at a cost of nearly $150,000. The building will be four storeys high, of brick and reinforced concrete construction.

The Edmonton School Board has just authorized an issue of $850,000 of forty-year debentures at five per cent. Most of the money will be expended on buildings, the balance for improvement of real estate and equipment of schools.

Three hundred and eighteen permits for buildings, estimated to cost $750,922, were issued in Edmonton during April. Four hundred and seventeen permits, involving $2,080,380, were issued during the same month last year.

Preliminary contracts in connection with the Royal Jubilee hospital at Victoria, B.C., are now being awarded. The estimated cost of the building is $400,000. The architect is Mr. L. P. Rixford, of Victoria and San Francisco.

Announcement is made that the Confederate Securities Company, recently incorporated with a capital of $250,000, will erect a four-storey office building, costing $90,000, in Edmonton this year. The structure will be 66 by 128 feet.

At Regina, nine tenders were received for the erection of a ladies' residence and towers at Regina College. The successful contractors are Messrs. R. J. Lecky & Company, Regina, whose tender for the entire work amounted to $147,800.

Mr. Albert W. Coate, manager of the Wallace Sandstone Quarry, Limited, expressed the opinion at Regina recently that the raising of the tariff on the finished product would not result in any increased cost on building stone to Canadian contractors.

Sand & Gravel Deposits, Limited, is the name of the latest Saskatoon company to have been incorporated a joint stock company. Mr. A. C. McKeown is president of the company which is capitalized at $100,000. The head office is in Saskatoon.

The contract for the extension of the water and sewer system at Swift Current, Sask., has been let to Mr. S. Holmes, a Regina contractor, at $40,000. Mr. Thos. Barnard has secured the contract for erecting the Rose theatre at Regina, at a similar amount.

Calgary contractors have petitioned the Dominion government to call for separate tenders for the new post office which is to be erected in that city at a cost of $1,000,000. The building is to be six storeys high. It will be faced with marble and granite.

The city of Edmonton will probably submit a bylaw to raise $175,000 for the construction of a filtration plant with a capacity of five million gallons. The amount was passed last year, but the bylaw may have to be submitted again to comply with a legal formality.

At Saskatoon, the erection of the stores and offices on Third Avenue for J. C. Drinkle is well advanced. The building will be ten storeys high, of brick, stone and reinforced concrete construction, and will cost $600,000. The architects are Messrs. Thompson & Crockart, of Saskatoon.

Constructional activity is increasing in Regina, Sask., and many large building and engineering undertakings have already been started. It is proposed to erect a 5,000,000 gal. rectangular reservoir on the site of the old power house. The dimensions are 250 feet by 155 feet with a depth of 23 feet.

The provincial government of B. C. has invited tenders for the proposed steel and concrete bridge across the Pitt River, on the Dewdney trunk road, at an estimated cost of $700,000. The tenders are to be in the hands of the Hon. Thos. Taylor, Minister of Public Works, by noon on May 26.

The Moose Jaw ratepayers have approved of a by-law to raise $301,000 for sewerage and waterworks, details of which are as follows: completion of Sandy Creek waterworks, $25,000; sewage disposal plant, $30,000; completion of subway, $28,000; storm sewers, $115,000; sanitary sewers, $43,350;

bridge, Eighth Ave., $30,000; high pressure waterworks system, $30,000.

A new 12-in. main, providing an additional supply of approximately 1,000,000 gallons a day, has been completed at Victoria, B.C. This brings the total daily supply available from the Esquimalt Waterworks Company to 56,000,000 gallons. By next fall the pipe lines of the Sooke system will be laid from Victoria to a point beyond Parson's Bridge, so that a permanent connection with the system of the Esquimalt Waterworks Company will be made.

Good progress is being made on the construction of the new bank and office building which is being erected on Portage Avenue, Winnipeg, for the Quebec Bank, by Messrs. Carter-Halls-Aldinger. The building is 108 ft. by 62 ft. in dimensions and is of brick and reinforced concrete construction. There will be four storeys with basement. The estimated cost is $225,000. Messrs. Brown & Vallance, of Montreal and Winnipeg, are the architects.

At Edmonton, Alta., an Armory building is to be erected for the Federal government at a cost of $280,000. The permit was issued on May 8, and work will begin at once. The building will have a frontage of 174 feet and a depth of 240 feet. It will be of brick with concrete foundation and steel superstructure. The plans were prepared by Messrs. D. E. Ewart and E. C. Hopkins, the contractors being the C. Lyall and Sons Construction Company, Limited.

Work on the first of the buildings for the Provincial University at Point Grey, B.C., is to be commenced this summer, the plans for the Science Building being completed by the architects, Messrs. Sharpe & Thompson. The west facade of the building is 250 feet long and averages about 55 feet in depth. With the various buildings around it the structure will eventually take the shape of a quadrangle. The elevations are to be constructed of Brandon stone of a brown or buff color, taken from the British Columbia quarries, while the facing around the windows and other relief work will be of dressed stone. The design is a modern adaptation of the Tudor style of architecture.

Construction on the Saskatchewan tuberculosis sanitarium at Fort Qu'Appelle, near Regina, has been resumed, and the contractors to date are as follows:—Parsons Construction Company, construction of buildings, $118,100; Connor Bros., Winnipeg, heating and plumbing, $27,855; North West Electric Company, Regina, engines, generators, switchboard, mechanical and electrical supplies, $11,112; Canadian Kellogg Company, Winnipeg, radial brick smoke chimney, $3,415; Stewart Machine Company, Winnipeg, laundry machinery, $3,850; Mr. Geo. E. Siebert, Winnipeg, refrigerator plant, $4,397; Mr. O. M. Smith, Winnipeg, water reservoir and pipe line, sewage disposal plant and sewers, $17,507.

Canadian Railroad Development

The Intercolonial Railway is installing the single-mile block signal system on its roads between Moncton, N.B., and Painsec Junction.

The Dominion Government has signified its approval of a bill to incorporate the Rainy River Radial Railway, which seeks authority to operate south to two points on the International boundary.

Two million dollars, at the rate of $300,000 a month, will be expended this year by Mr. J. D. McArthur, builder of the Edmonton, Dunvegan & British Columbia, and the Alberta & Great Waterways railroads, according to official announcements made in Edmonton on May 8. Seven hundred thousand ties have been cut and steel for 230 miles of line is on hand.

Personal Mention

Mr. Paul Mercier has been appointed Assistant City Engineer of Montreal at a salary of $5,000 a year.

Mr. C. C. Mendham has been appointed resident engineer in Berlin, Ont., for the Herbert Morris Crane and Hoist Company, Limited, Toronto.

Mr. Walter Lyon has been appointed the Montreal representative of the Standard Ideal Company, Limited. Prior to this Mr. Lyon was with the Standard Sanitary Company, Toronto.

Mr. William McNab, Principal Assistant Engineer of the Grand Trunk Railway, has been elected President of the Canadian Railway Club. He is a member of the Canadian Society of Civil Engineers and of kindred societies. Mr. R. M. Hannaford, Assistant Chief Engineer of the Montreal Tramways Company, is the Second Vice-President of the Railway Club, and Mr. James Powell, Chief Draughtsman of the Grand Trunk Railway, is Secretary.

Mr. R. S. Lea, of Montreal, has been appointed consulting engineer of Fort Garry, the municipality adjoining the city of Winnipeg to the south. Mr. Lea will advise the town in regard to the installation of new water and sewerage systems.

Mr. R. W. Burnett, master car builder, C. P. R., has been presented with a past president's medal of the Canadian Railway Club on retiring from the position of president. Mr. J. Hendry, master car builder, G. T. R., and Mr. G. Smart, master car builder, I. C. R., Moncton, have been elected members of the executive committee of the club.

Mr. Wm. Wainwright, Sr., vice-president of the G. T. R. and G. T. P. railways, died last week. He was born at Manchester, Eng., in 1840 and entered the service of the Grand Trunk Railway at the age of 22 a senior clerk to the chief accountant at Montreal. He rose rapidly and after filling the positions of general passenger agent, assistant manager and assistant general manager, he became, in 1896, general manager of the entire system. His appointment as vice-president was made within recent years.

The all-steel passenger car which the C. P. R. has adopted, has several original features, one of these being the roof which has been designed on the "modified turtle back" type, and is said to give the maximum of light and ventilation. The car is ten feet wide, eighty-two feet long, seats eighty-four persons and weighs 114,800 pounds. It is estimated that the cost of replacing the wooden cars on all the lines, with all-steel coaches, would cost approximately six hundred million dollars.

In New Brunswick generally, constructional operations are proceeding briskly. Railway enterprises are being pushed along as quickly as possible. In St. John, the harbor works are being pushed, but there is a feeling that the progress is not as fast as it should be, or as fast as the circumstances demand. No doubt during the coming season this very important scheme of port development will be taken up with more determination as a great deal is depending upon it. Building enterprises throughout the provinces are very active. This is particularly the case in St. John, where several large buildings are in progress of construction and where the housing problem is being met by the erection of a number of residences in attractive localities.

ESTABLISHED 1886
Contract Record
and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 May 27, 1914 No. 21

Principal Contents

The Making of a Technical Journal ... 669
A Revised Price List ... 670
Small Contracts for Large Works ... 670
Inadequate Time for Preparation of Tenders ... 670
Canadian Constructional Centres ... 671-6
Part III. (Conclusion)
Reinforced Concrete Storage Dam at Swift Current, Sask. ... 677
By W. F. Farley
The Efficiency of Waterworks Devices ... 679-80
Building Construction in Nova Scotia ... 681-2
Drill Boat for Submarine Blasting at Vancouver, B.C. 682
Thermal Properties of Concrete ... 683
Features of the Northern Electric Company's New Plant at Point St. Charles, Que. ... 684-7
The Artistic Possibilities of Bonds and Mortars in Brickwork ... 688-91
Part II. (Conclusion)
A Discussion of Coal-Tar and Asphalt Products for Waterproofing ... 692-3
By S. T. Wagner
Fire-Resistant Construction and Equipment of Buildings ... 693-4
Montreal Road Congress ... 695-8
(Staff Report)
Personal, Constructional and Industrial News ... 699-702

The Making of a Technical Journal

ONE of the most interesting and informative papers we have read in a long time is an address before the Western Society of Engineers, delivered by Mr. E. J. Mehren, Editor of the Engineering Record. In several respects, the paper, which comprises a review of the organization, work and functions of the technical journal, might be taken as the text for an interesting editorial, but it is sufficient for the purpose in hand to comment upon one or two points.

In the first place it is of interest to note the manner in which Mr. Mehren traces the development of the technical journal. Time was when its primary function was to supply the engineer with information as to the latest developments in the field, but gradually there came a demand for information as to constructional methods, equipment, news of enterprises, and so on—a demand which has taken the technical journal out of the strictly professional class and made it an indispensable business commodity as a specialized news organ.

The importance of the Contract News section is well emphasized. It may not be out of place, perhaps, to say that this particular section of the Contract Record has been developed and improved upon for years until now it is conceded that the service is approaching a state of real usefulness. Mr. Mehren tells us that "the secret of true and reliable news gathering lies in the development of a strong and interested clientele" and that "such a clientele is the chief asset of a technical journal." With this we are entirely in accord. The evidence of "a strong and interested clientele" in the Annual Number of this journal (May 13) was most gratifying.

A useful pointer is given to engineers and contractors in the advice to compress descriptive material within the smallest possible limits consistent with lack of ambiguity. Undoubtedly the padding habit is the worst fault of contributors to this kind of journal. The padding may be done unconsciously, but it is there, and it detracts from the value of an otherwise useful contribution. In this respect Mr. Mehren says: "The engineer naturally feels that his own project is of transcendent importance and, instead of picking out the unusual or most interesting features, he describes details that are of interest only to himself and to his associates in the work. . . . . Five one-column articles are preferable to one five-column article."

The desirability of appealing to the "human" side of the engineer is well made the subject of special mention. Assuredly the live technical journal of to-day must get away from that "deadly sameness" which characterized the pioneers in the field. To be really successful a journal must disclose careful thought and enterprise: thought in its editorial policy and enterprise in every department of its activity. A continuous effort must be made to secure live, informative illustrations—pictures that disclose, in part at least, the story of the work.

In the future of technical journalism Mr. Mehren sees wonderful opportunities for expansion. Here again we are entirely in accord with his views. We feel that in Canada, particularly, there is room for the development of such a paper as the Contract Record and Engineering Review upon such a scale as to make it a sine qua non in the life of every man identified with constructional enterprise. Mr. Mehren shows very well the part of the technical journal in expounding sound doctrine and in influencing the general public through the medium of the daily newspapers. We cannot think that in any other country than Canada can such a part be more potential.

Mr. Mehren has shown us a policy which has established his own journal on a high pinnacle of usefulness and attainment, and by the same token he has confirmed our views as to the means of reaching such a pinnacle of achievement on this side of the border.

A Revised Price List

IT may be an opportune time to direct the attention of the reader to the current price list of constructional materials published in this journal in an entirely revised form. We are now publishing Montreal, Toronto, Winnipeg and Vancouver prices and we shall appreciate co-operation on the part of the reader in keeping the information reliable and up-to-date. We are anxious to have suggestions and to know of any errors or deficiencies.

Of price lists in general, time and time again the complaint has been made that the material is "stale," that it is impossible to keep it up-to-date; that the figures given are inspired by manufacturers, and so on. In all such charges we take it that there is a vestige of truth, but we hope to eliminate most of these troubles and to give such quotations as may provide ready reference for the engineer and contractor—particularly in the way of comparative information. By frequent revision and painstaking work we hope to maintain a high average of accuracy. Occasionally the information may not reach us sufficiently in advance of publication to enable us to make the desired change—as in the case of a sudden fluctuation in some commodity at, say, Vancouver—but this will be obviated largely by enterprising telegraphic work on the part of the correspondents of this journal in the various centres of activity.

We are inclined strongly to the opinion that this department has functions second only in importance to the Contracts Department. The current price list of this journal, conducted on the lines we have inaugurated, will enable the engineer, architect and contractor to run up a preliminary estimate for work in any section of the country. Naturally, the final figures will arise out of a close personal investigation, depending largely, as such figures do, upon local conditions and the particular character of the work—to say nothing of financial arrangements, but the preliminary estimate plays an important part in contracting operations.

The prices from the various centres will be supplemented by periodical reviews of trade conditions. To such reviews our readers are invited to contribute. Information appertaining to actual prices on the leading lines of material in various places will be particularly valuable. Manufacturers and dealers in builders' supplies are asked to submit weekly price lists for the inspection of those seeking such information at the office of this journal. Supplementary quotations will be given upon request.

The reader is urged to co-operate with us in making this feature indispensable to him.

An International tunnel, said to be the only one in North America to cross an international boundary line, is about to be started on the San Diego & Arizona Railway. Although the bore will be only 620 ft. long, one end will be in the United States and the other in Mexico.

Small Contracts for Large Works

UPON engineers who have to place under contract work involving the expenditure of many thousands of dollars there rests a grave responsibility, comments the Engineering Record editorially. Every large undertaking consists, in effect, of a number of lesser construction operations, related to one another more or less closely, and it is puzzling to determine whether the best interests of a city will be served by awarding one contract for the whole job or by dividing the work into its several elements and receiving separate bids on these smaller units. A case in point is the new mechanical filtration plant at Baltimore.

There is a very interesting moral in the history of the award of this work. At first the principal parts of the plant—the filters, filter equipment, mixing and coagulating basins—were grouped under a single contract. Only three bids were received and all of them were so much in excess of the estimated cost which the city's engineers had prepared that the bids were rejected. The total amounts of these three tenders were remarkably close—the lowest, $971,187, the next, $982,563 and the highest, $1,016,525. On work involving close to a million dollars, the difference between the highest and the lowest bid was only about 4½ per cent. After the bids were rejected the work was divided into smaller contracts and readvertised. The competition was much keener and lower prices were secured. By comparing the lowest original bid, $971,187, with items of a similar nature awarded in subsequent contracts and allowing $22,400 for the price of the filter operating tables, which were not included, a saving of $323,897 was made. From his experience with the Baltimore contracts Mr. J. W. Armstrong (engineer of the city's filtration division) draws the following conclusion: "In public work involving large expenditures where different kinds of construction are involved cheaper and better work can be obtained by dividing it into smaller contracts so that men can bid directly upon the special work in which they are most interested." Of course all engineers will not agree with this conclusion. Often the large contractor's resources in plant, organization and capital are so much greater than those of his smaller competitors that he can underbid them, but there must be sufficient competition to induce him to submit his best figures. It was the division of the work into the smaller units that secured keener competition at Baltimore.

Inadequate Time for Preparation of Tenders

UPON more than one occasion we have voiced editorially the familiar complaint of an inadequate period for the preparation of tenders. We had thought that Canadian municipalities were particularly offensive in this regard, but from an editorial note in a recent issue of Engineering and Contracting they would appear to have competitors in malpractice across the border. Our contemporary's observations, which follow, are to the point.

"Three small cities opened bids last week for public improvements. In each case the time from the first insertion of the official advertisement to the opening of proposals was only seven days. The works were comparatively small as construction undertakings go, yet they were of the utmost importance to the municipalities proposing them. They had been under discussion for many months, the necessary legislation had consumed much time, the preliminary arrangements had taken weeks, and yet when it came to the really important part—the placing of the work under contract—contractors were allowed but one week in which to prepare their bids. This of course cut down the competition. Contractors who had followed the proceedings closely were able to put in their figures. Others who would have been glad of the opportunity of submitting estimates on the work learned of it too late. Instances like these are of frequent occurrence. A small city or town will proceed with the utmost deliberation in getting ready for an improvement and then when the final decision to go ahead is reached there is a hurry up call for bids. Very often the official advertisement is inserted only in the local paper. When this happens the outside contractor, unless he has been notified by the engineer or municipal officials, usually secures his first information of the work from the news columns of the technical journals. It is then often too late for him to obtain the plans and specifications, visit the city, and make the necessary investigations preparatory to submitting a bid. The time element in a public works letting is of the utmost importance both to the municipality and to the prospective bidders. If plenty of time is allowed for the preparation of bids there will be increased competition and better prices will be obtained. Where the time limit is so short that contractors cannot investigate carefully and figure accurately they will either pass up the work or will put in bids high enough to protect themselves from all risks."

Canadian Constructional Centres

A Compendium of Engineering and General Progress Data Relating to the Activities of the Principal Towns and Cities of the Dominion. Arranged Alphabetically by Provinces.

Newfoundland, Nova Scotia, P.E.I., New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia

PART III—Conclusion

WITH Part III, embracing the cities and towns of Alberta and British Columbia, the series of articles relating to the constructional activities of the Dominion is brought to a close in this issue. As stated previously, the aim has been to provide the reader with a ready reference to the engineering equipment of the various municipalities throughout the country and to provide such general figures appertaining to construction as will enable him to arrive at an estimate of recent progress and make deductions accordingly.

It is suggested that this feature be published periodically by the Contract Record and Engineering Review. There would appear to be some ground for this request inasmuch as the information soon becomes "stale" by virtue of the rapid development of the country. It would be a matter of interest to have the views and criticisms of those of our readers who have found value in this series and to publish them in an early issue. The assurance need hardly be given that the suggestions advanced will not die a natural death in the file copies of this journal, but will be tabled for careful consideration in due course. This is essentially a case for the co-operation of the reader.

The towns and cities of the Dominion have now been featured from coast to coast. In Part I. of this series, published in our Annual Number on May 13, we gave the towns and cities of Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick and Quebec, and the cities of Ontario. Part II., which appeared on May 20, comprised the towns of Ontario and the cities and towns of Manitoba and Saskatchewan. Alberta and British Columbia now write Finis to the series.

Alberta

Bassano, Alta.

The history of Bassano dates back only three years, the town having been incorporated in 1911. The population today is 2,000 and the property is assessed at $1,750,000. The 1914 estimate of building work is $150,000 and of engineering work $20,000. Last year's tax rate was 19 mills. The town has three miles of graded roads. The town sewerage system extends 1½ miles, with 2½ miles out-fall. Sewage disposal works are now under construction, the extensions planned this season involving an outlay of $5,000. The garbage is destroyed by a Reid incinerator. The water supply is from the Bow River, 3½ miles from the town, the water being pumped into a 200,000-gal. stand pipe. Waterworks extensions are planned at a cost of $7,000.

Calgary, Alta.

The city of Calgary has a population of 80,000. It was incorporated in 1882 and received its city charter twelve years later. In 1909 the population was 30,000. Calgary's extension during recent years has been phenomenal. In no respect is this in greater evidence than in the value of the permits issued for building construction, the returns for the last five years having been as follows: 1909, $2,420,450; 1910, $5,589,594; 1911, $12,907,658; 1912, $20,394,220; 1913, $8,619,653. The estimated building expenditure for 1914 is $10,000,000. The following classification of expenditures in the City Engineering Department during 1913 may be of interest: waterworks extensions, $621,120; sewer extensions, $672,283; paving and grading, $743,347; electric light extensions, $362,431; power extensions, $248,527; street railway extensions, $617,981; paving plant, $50,000. The city has ninety-five miles of graded roads and 54 miles of paving, the classification being as follows: (1) unmetalled dirt roads; (2) wood block; (3) asphalt; (4) concrete; (5) asphaltic concrete; (6) bitulithic. The 1914 programme of road work has not been completed at the time of writing. The sewerage is largely a combined system, especially in the central area of the city. Separate storm sewers are being put in for the outlying districts. The method of disposal is by gravity into the Bow River. Designs are now being prepared for a disposal plant, for which the estimates have not yet been completed. The garbage is collected in single horse dump carts and electric trucks, and is taken care of by two incinerators. With reference to garbage collection, the following figures as to the cost of electric tractors may be of interest. These machines have been in operation about twelve months and have run, on an average, 510 miles a month. The total cost for upkeep, maintenance, repairs, garage rent, salaries, etc., has been $260 a month exclusive of depreciation. The Engineering Department figures that the total cost of the trucks, some $5,500, will be written off in seven years. The city obtains its water supply from the Elbow and Bow rivers, the main supply being by gravity from the Elbow river, the secondary supply being pumped from the Bow river.

Camrose, Alta.

This town has a population of 2,100 and was incorporated in 1907. The 1914 assessment is $1,700,000 and the tax rate 27 mills. It is estimated that $300,000 will be the value of building work and $20,000 the engineering expenditure this year. Of a roadway mileage of twenty, earth roads comprise nineteen miles and macadam roads one mile. Eight thousand dollars has been set apart for road work this season. The sewerage system extends three miles, disposal being by septic tanks and the effluent being treated with chloride of lime. Sewerage extensions planned this season involve an outlay of $6,000. Garbage is dumped on a nuisance ground and burned. The water supply is from three artesian wells, and extensions to the waterworks will be made this season at a cost of $6,300. The electric light and power plants will be enlarged at a cost of $4,000.

Cardston, Alta.

This town, incorporated in 1901, has a population of 1,600—an increase of about 500 in the last five years. The assessment for 1914 is $29,000 and the tax rate 25 mills. It is estimated that $260,000 will be spent on building work this season. There are thirty miles of clay and gravel roads, with sixteen blocks of cement and six blocks of wooden sidewalks. There is a surface drainage system of sewerage with outlet into Lee's Creek. The garbage is collected in wagons and deposited on a dumping ground outside the town limits. Water is obtained from Lee's Creek. Ten-inch wooden pipe mains are used. The waterworks are reported of sufficient capacity to provide for a population of 8,000. The erection of a concrete dam and the installation of an intake are contemplated. In the way of electric light, service and street lighting extensions are contemplated.

Coronation, Alta.

This town, incorporated just two years ago, now has a population of 1,200, with an assessment of $700,000. The estimated building expenditure this year is $500,000 and on municipal engineering work $45,000. Last year's tax rate was 31 mills. At present there is no system of sewerage, but work involving $20,000 is under consideration. The water supply is drawn from wells. Extensions to the waterworks at a cost of $40,000 are now being put in hand, as also are extensions to the electric light plant, involving an outlay of $15,000.

Edmonton, Alta.

It is just ten years ago since the Alberta capital received its city charter and twenty-two years since it was incorporated a town. Its growth during recent years has been spectacular, the population having increased from 21,000 in 1909 to 70,000 in 1914, and its assessment in the same period from twenty-five and a half millions to one hundred and eighty-eight million dollars. In 1913 the tax rate under the single-tax system was 16 mills. The estimate of building work to be carried out during 1914 is ten million dollars—rather more than four times the actual value of the building work done in 1909. This season there will be an expenditure of $1,125,000 on paving, $77,328 on concrete walks and $642,500 on sewers. The city has 41.61 miles of paved streets, 27.92 miles of boulevards, 100 miles of graded roads and 335 miles of unimproved roads. There are 120 miles of sewers. The extensions planned for the present year comprise a total of approximately forty miles at an estimated cost of $2,000,000. A trunk system is under construction, this being built entirely in tunnel varying in depth from 40 ft. to 100 ft. below the ground surface. The tunnel system discharges into the Saskatchewan river through a 10 ft. 6 in. sewer. The latter is constructed of concrete blocks, around the outside of which when built into the sewer, is placed a steel band. About eight miles of this type of sewer have already been constructed, with satisfactory results. The sewerage is a combined system as far west as 21st Street. West of this a separate system is employed, the sewage being discharged into the North Saskatchewan River. At one outlet the sewage discharges into a separate tank. Garbage is disposed of by incineration. The water supply is from the North Saskatchewan River, the water being pumped by low lift pumps to a filtration plant, the filtered water being pumped directly into the distribution system by low lift centrifugal pumps to a sedimentation basin, and thence through a gravity mechanical filter to the reservoir. After being treated with hypochlorite of lime, it is pumped by service pumps into the distribution system. The street railway system, like all the other utilities, is municipally owned. During 1913 an extensive programme of track construction was carried out. Extensions to the electric light system will be made this season at a cost of $152,000.

High River, Alta.

Incorporated eight years ago this town has a population of 1,500 as compared with 1,000 in 1909. The assessed valuation of the town is $1,335,000. The combined expenditure on building and engineering work this season will be $60,000. The town has five miles of graded roads, upon which $50,000 will be expended in improvements this season. A sewerage system discharging into the river is now under construction. Extensions to the system are planned at a cost of $5,000. The garbage is collected and deposited on a nuisance ground. The water supply is from the Highwood River, the water being pumped to a 160,000-gal. standpipe.

Lacombe, Alta.

This town was incorporated in 1902 and the population figures for 1909 and 1914 are 1,100 and 1,800. The present assessment is $596,000 under the single tax system, and the 1914 tax rate is about 40 mills. No reliable estimate of building and engineering work is obtainable. There are about seven miles of roadways, five of which are earth and two are macadamized. There is no system of sewerage and the garbage is dumped on a nuisance ground. The installation of a waterworks system is contemplated at a cost of about $30,000.

Lethbridge, Alta.

The town of Lethbridge received its charter in 1890 and became a city in 1906. Two years later its population was 6,085, while to-day it is 11,500. The assessment is $17,000,000, as compared with $5,000,000 in 1909. The value of building in the latter year was $1,268,215 and of engineering work $198,000, while the 1914 estimates for building and engineering are $2,250,000 and $258,000 respectively. There are thirty-three miles of clay roads and 1.6 miles of paved roads. Details of classification further than asphaltic concrete, concrete and clay are not given. The city's sewerage system comprises thirty miles of sanitary sewers and three miles of storm sewers. The method of sewage disposal is by sedimentation tanks, sprinkling filters and humus and chlorinating tanks. The garbage is collected by carts and burned on a dump. Paper is burned in a portable incinerator. The water supply is from the Belly River, the water being pumped to two standpipes, and the waterworks system consisting of thirty-six miles of cast iron, wood and steel mains. The installation of a new high pressure system is contemplated at a cost of $80,000. Electric light extensions will be made at a cost of $10,000. The municipal affairs of Lethbridge are administered under the commission form of government.

MacLeod, Alta.

This town was incorporated in 1889, has a population of 3,000 (2,000 in 1909) and is assessed under the single-tax system at $5,000,000. The 1914 tax rate is 13 mills. The 1914 estimate of building work is $150,000. There are twelve miles of macadam and gravel roadways. A combined system of sewerage is in operation, the sewage being discharged into the river. The extensions contemplated comprise sewage disposal and trunk sewer at a cost of $65,000. Garbage is collected and deposited on a dump. The water is obtained from the Old Man River, there being approximately nine miles of mains and fifty-five hydrants.

Medicine Hat, Alta.

Medicine Hat was incorporated as a town in 1899 and as a city eight years later. Its population of 3,500 in 1909 has now increased to 14,000. The tax rate for the present year is 15 mills. The value of building in 1909 was, roughly, $200,000, as compared with the 1914 estimate of $3,000,000. The 1914 estimate of engineering expenditure is $660,000, compared with an expenditure of $60,000 in 1909. The city has twenty-five miles of macadam and gravel roadways, upon which there will be an expenditure of $60,000 this year. A separate system of sewerage is in operation. The surface sewer system is to be extended at an estimated cost of $90,000. There is no method of disposal. Garbage is collected in carts and dumped. The water is taken from the Saskatchewan River and filtered mechanically. The waterworks extensions planned involve an expenditure of $120,000, divided equally between plant and distribution. Extensions to the electric light system will be made this year at a cost of $60,000. The reader need hardly be reminded that one of Medicin Hat's main assets is its natural gas, which is sold to the domestic consumer at 13½c net and to the manufacturer at 5c net. The electric light and power plant is municipally-owned.

Raymond, Alta.

The town of Raymond was incorporated in 1903. Six years later its population was 1,700, which has now increased to 2,000. The 1914 tax rate is 30 mills and the estimate of building work is $75,000. There are twenty-five miles of earth roads. There is no sewerage system, neither is there any method of garbage disposal. The water supply is obtained from a well.

Redcliffe, Alta.

Although Redcliffe came into existence as a town as recently as 1912, it has a population to-day of 3,000. The assessment for 1914 is in the neighborhood of $7,000,000. The figures regarding tax rate and building for 1914 are not available, but the expenditure on engineering work this season is estimated at $250,000. Plans are in course of preparation for a system of sewerage. The garbage is collected by contract and burned. The water supply is from wells near the South Saskatchewan River, the water being pumped into a steel water tank having storage capacity of 300,000 gals. A scheme is under consideration for extending the waterworks four miles, with house connections and meters at an estimated outlay of $75,000. The town is lighted by natural gas.

Red Deer, Alta.

Incorporated as a town in 1901 and as a city in 1913, Red Deer has a population of 3,500, an assessment of $4,383,380 and a tax rate of 15 mills. The value of building for 1914 is estimated at $150,000 and engineering work will cost $15,000. On street and roadway improvements this season the sum of $3,000 will be expended. There is a combined system of sewerage, the sewage being discharged direct into the Red Deer River. Extensions to the system will be made at a cost of $75,000. The water supply is from the Red Deer River, the water being pumped into mains from a gravity filtration plant.

Stettler, Alta.

The population of this town, which was incorporated in 1908, has increased from 1,200 in 1909 to 1,800 in 1914. The assessed value of the property is roughly $1,000,000. The tax rate for 1914 will probably be 28 mills. The town has 20 miles of graded roads upon which an expenditure of $1,000 will be made this season. The garbage is collected by scavengers and deposited on a nuisance ground. The water supply is from wells, the system including an elevated tank. Waterworks extensions projected will cost $1,500 and electric light extensions $1,000.

Taber, Alta.

This town was incorporated in 1907. It has a population of 3,000 and was assessed last year under the single tax system at $1,285,000. The 1913 tax rate was 38 mills. There are no municipal improvements in the way of roads or sewerage. The water suply is from the Belly River. Waterworks extensions are planned at a cost of $15,000.

Vermilion, Alta.

This town was incorporated in 1906. Its population is 1,250, which is double that of five years ago. The 1914 assessment is $1,723,357 and the tax rate 29 mills. The value of building work this year is estimated at $75,000 and of engineering work at $2,000, the latter sum covering preliminary expenses for sewerage and waterworks. There are three miles of graded roads. About $5,000 will be expended on road work this season.

Wetaskiwin, Alta.

Incorporated as a town in 1902 and as a city four years later, Wetaskiwin has a population of approximately 3,500. The assessment for the present year is estimated at $3,650.000. The tax rate in 1913 was 22¾ mills. There are about nine miles of earth roads in the city. Concrete sidewalks are laid through the entire business section, and extensions estimated to cost $2,500 are on the 1914 programme. A combined system of sewerage is in operation. The sewage disposal plant is located less than four miles east of the city, the Owens live earth bed system being employed. Sewerage extensions will be made at a cost of $6,000. The garbage is deposited on a nuisance ground and burned. The water supply is obtained from three wells, the water being pumped by compressed air to a concrete reservoir of 212,000 gals. capacity, thence by gas or steam pump to an elevated tank of 120,000 gals. capacity.

British Columbia

Armstrong, B.C.

Armstrong was incorporated in 1913. The town has a population of 1,400, an assessment of $860,000 and a tax rate of seventeen mills. The building programme this season is estimated to total in value $30,000. There are twenty miles of gravelled roadways, upon which an expenditure of $50,000 is planned. The water supply is from Davis Creek.

Cranbrook, B.C.

Cranbrook was incorporated in 1905 and has a population of 3,500, with an assessment of $2,000,000. The 1914 tax rate is 28 mills. It is estimated that $12,000 will be spent on municipal engineering work this season. There are 12½ miles of earth and gravel roads and $9,300 will be expended on road work this season. The sewage is filtered and the effluent discharged into St. Joseph's Creek. Garbage is deposited on a dumping ground. The water supply is from St. Joseph's Creek.

Fernie, B.C.

This city was incorporated just ten years ago. It has a population of 5,500, the increase in recent years having been small. The 1913 assessment was roughly $2,700,000 and the tax rate 24 mills. In 1909, following a disastrous fire which practically consumed the city, the value of building was approximately $1,500,000 and of engineering work $120,000. The 1914 estimate for building is $30,000 and for engineering work $11,000. The city has eleven miles of roads, with no permanent pavements or macadamized highways. An expenditure of $10,000 on road work is contemplated. A separate system of sewerage is installed, the method of disposal being septic tanks. The city limits are practically all sewered, with the exception of a small residential district, the sewers for which are estimated to cost $14,000. No extensions will be made this season. Garbage is deposited on a dumping ground and burned. The water supply is from Fairy Creek. A concrete dam has been built across the Creek and the water is led from the reservoir thus formed by a 12-in. wooden main to the city. The length of main from the reservoir to the centre of distribution is three miles. The storage reservoir, which is close to the city, has a capacity of 750,000 gals. The electric light system is to be enlarged this season at a cost of $9,000.

Kamloops, B.C.

This city has just attained its majority, it having received its charter in 1893. Its population to-day is 6,000—the figures having doubled in the last five years, during which period the assessment has increased from $130,000 to nearly six millions. The tax rate this year is 24¾ mills. The building expenditure in 1909 was $37,000 and the engineering expenditure $10,000, and the 1914 estimates are $425,000 and $60,000, respectively. The roadway mileage is 30. All the roads are earth, but permanent types are now under consideration. The estimated expenditure on road work this season is $3,000. The sewerage is a separate system, the method of disposal being by septic tanks. A scheme to embrace the sewerage of the whole city is under consideration. In this department there will be no expenditure during 1914, but next year there will probably be an outlay of $10,000. The city has adopted no system of garbage collection and disposal, but incineration is under discussion and a scheme will probably be brought forward next year. The city derives its water supply from the South Thompson River. The waterworks, as installed, provide for future filter beds. The main undertaking at present is the completion of a hydro-electric power plant, the total cost of which has been over $400,000. The matters which will come up at Kamloops next season and in subsequent years may be enumerated as follows: permanent roads; sewerage of east end; sewage disposal plant for the whole city; waterfront improvement; filtration plant.

Ladysmith, B.C.

Incorporated just ten years ago, this town has a population of 3,500. The assessed value of the property is one and one-quarter millions, and the estimate of the building work to be carried out this season is $500,000. There are ten miles of gravel roads. The sewage is discharged into the harbor, there being ten miles of mains. Minor extensions to the sewerage system are planned. The garbage is collected by teams and there is no method of disposal other than dumping. The water supply is from Stocking Lake. The waterworks system is owned by the E. & N. Ry. Waterworks Company. Improvements to the electric light system are to be effected at a cost of $4,000.

Nanaimo, B.C.

This city of 9,000 inhabitants was incorporated just forty years ago. Its population has increased 2,000 during the last five years. The assessment is roughly seven and one-half million dollars, and the tax rate for the year is 32 mills. There are 16½ miles of paved streets and macadam roads In the way of road work, asphaltic concrete is planned this season at a cost of $220,000. The sewerage is a separate system, the sewage discharging into the harbour. There are about ten miles of sewers. This season the system is to be completed by the addition of about six miles at a cost of $75,000. From the Nanaimo River water is brought in sixteen miles by gravity. Waterworks extensions planned total $50,000. The electric light system is owned by the Nanaimo Electric Light, Power & Heating Company, Limited. The system is to be enlarged by two miles of pole line.

Nelson, B.C.

Nelson was incorporated in 1897. The city has a population of 7,500 and an assessment of $4,320,896. There are over sixteen miles of streets, most of which are earth, only one-half mile being macadam and two miles gravel. The sewerage is about nine miles in extent and discharges into the lake. The city collects the garbage, which is disposed of on a dump. The source of the water supply is Cottonwood Creek and Anderson Creek.

New Westminster, B.C.

The city of New Westminster was incorporated in 1861. Its present population is 17,178 and its assessment, roughly, $17,000,000, as compared with a population of 10,000 and an assessment of $5,000,000 in 1909. The 1914 tax rate is 20 mills. This year the building work is estimated to cost $850,000 and the municipal engineering work $600,000. The mileage of roadways for the whole city is 98, classified as follows: Bitulithic, 3.50; Hassam, 3; granite setts, .50; wood block, .30; vitrified brick, .30; macadam, 30; balance, rough-graded. The sewerage system consists of 43 miles on the separate system and 6½ miles of storm sewers. The method of disposal is by dilution into the Fraser River. The sewerage extensions contemplated involve an additional forty-five miles of combined sewers, the total cost of which will be $850,000. At the time of writing, contracts have been let for $200,000 worth of work. The combined sewer which is being constructed is divided into two watershed areas, one of which is approximately 1,300 acres, of which 650 lie within the boundary of the Burnaby municipality. The size of the out-fall for this scheme is 8 ft. by 6 ft. 6 ins. and is composed of reinforced concrete monolithic sewer, horse-shoe shaped in section. This will be built practically following the line of the existing Glen Brook, which it will eventually absorb. This section will be constructed partly in a ravine and is designed to withstand a new fill forty feet in height. Three thousand feet of this section will be built through the Penitentiary Reserve. The total discharge at the out-fall is calculated at 610 cu. ft. per second. The smaller watershed area of the Sapperton sewer, No. 2, comprises an out-fall of two 48-in. reinforced concrete pipes, to be manufactured by the Pacific Lock Joint Pipe Company. Before reaching the Fraser River, the point of discharge, a small creek known as the Brunette Creek, some fifty feet in width, has to be crossed by an inverted syphon. Before this syphon is reached, a large grit chamber is to be constructed, so that the grit can be handled at this point before reaching the syphon. Garbage is collected in wagons and disposed of partly in a small incinerator, the bulk, however, being dumped from scows into the sea. The water supply is from Lake Coquitlam, a pure mountain supply with no filtration required. The water is brought through 14 miles of 14-in. steel mains and 14 miles of 25-in. steel mains from the lake to the city. The maximum discharge from both mains is 8,000,000 gals. a day. The maximum head at lake is 503 feet and the highest reservoir in the city is 398 feet. This season it is planned to build a new reservoir and make other extensions, the whole to cost $75,000.

North Vancouver, B.C.

North Vancouver is a seaport town on the north shore of Burrard Inlet, opposite Vancouver. The city was incorporated in 1907 and has a population of 10,000. The assessment is rather more than $16,000,000. This year it is estimated that $300,000 will be expended on building work and a similar sum on engineering work. Tenders have been received for a bridge across the Second Narrows (between Vancouver and North Vancouver) estimated to cost $3,000,000. The roadway mileage is 60, made up of 13.5 miles of macadam and the balance earth. The expenditure on road work this season will be $75,000. Sanitary and storm sewers have been installed and the sewage runs into the deep water of Burrard Inlet. Sewerage extensions are planned at a cost of $35,000. Garbage is collected by teams, dumped and burned on tide flats. The water supply is by gravity from Lynn Creek, the water being brought into the city through a 16-in. main from an intake placed five miles above tide water. The side mains are partly of wood and partly of cast iron. The extensions planned comprise the erection of the Rice Lake Reservoir (capacity 150,000,000 gallons) at a cost of $175,000, of which, at the time of writing, $110,000 has been expended. North Vancouver, which is situated on the main line of the Pacific Great Eastern, has ten miles of first-class waterfrontage.

Port Alberni, B.C.

Port Alberni, which was incorporated in 1912, has a population of 1,100 and is assessed at $3,500,000. The building estimate for the season is less than $100,000, while the expenditure on streets, bridges and waterworks will be $15,000. The 1913 tax rate was thirteen and one-half mills. The town has twenty miles of gravel roads and the sum of $6,000 will be expended in road work this season, chiefly on sidewalk construction. Garbage is collected and buried. The water supply is from China Creek.

Prince Rupert, B.C.

The city of Prince Rupert was incorporated just four years ago and its population to-day is rather more than 6,000. The 1914 tax rate will be between 13 and 15 mills. The building permits issued to date amount to half a million dollars, while the estimate for the year is $2,500,000. The estimated cost of the completion of important undertakings is detailed as follows in the last annual report of the President of the Prince Rupert Board of Trade: Grand Trunk Pacific Railway: dry dock, $2,750,000; fifteen-storey hotel, $2,000,000; terminal facilities, docks, depot, shops, etc., $2,500,000. Dominion Government: post office, $250,000; quarantine station, $100,000; armory, $100,000. Provincial Government: courthouse and administration office building, $300,000. City Council: hydro-electric plant, $380,000; sewerage system and waterworks extensions, $500,000; section two bridge, $100,000. Imperial Oil Company: five large storage tanks, $200,000. Total, $9,180,000. Prince Rupert has 13 miles of plank roads, 7 miles of graded roads, and 7 miles of planked sidewalks. The expenditure on road work this season will be $65,000. The sewerage system consists of about three miles of vitrified pipe and wood stave sewers. The sewage empties into the harbor. Sewerage extensions planned involve an expenditure of $350,000. Garbage is collected by carts, loaded on a scow, and dumped into the sea. The installation of an incinerator is proposed. The water supply is by gravity and pumping from Hays Creek, Woodworth and Shawatlans Lake. The extensions planned (now under way) comprise the completion of the hydro-electric system and distribution system at an estimated cost of $237,000. Electric light extensions now under way, at a cost of $185,000, consist of a power house, pole line and distribution system. Further extensions will cost $60,000.

Revelstoke, B.C.

Revelstoke received its charter of incorporation as a city in 1899. It has a population of 4,000 and an assessment of $3,181,503. Building work for 1914 is estimated to total in value about $1,700,000, the estimate for engineering work being $16,000. There are three miles of cement sidewalks but no permanent streets. There is a gravity system of sewerage in operation, the outlet being into the Columbia River. The city's water supply is derived from mountain streams. It is proposed to expend $40,000 on the electric light system.

Salmon Arm, B.C.

This town was incorporated as recently as March, 1914. It has a population of about 1,000, an assessment of nearly $862,000 and its tax rate last year was thirteen mills. The building and engineering programme for the present season is estimated to involve outlays of $250,000 and $12,000 respectively. There are ten miles of common roads. The water supply is from East Canoe Creek and the extensions planned will cost $10,000.

South Vancouver, B.C.

The municipality of South Vancouver has a population of 40,000 and is assessed at rather more than $34,000,000, the assessment having increased from $6,500,000 since 1909. The expenditure on building work last year was $1,750,000. The area of the municipality is fourteen and a half square miles. In regard to street improvements the following mileage statistics may be found of interest: streets in municipality, 246.5; cleared and rough graded, 204; uncleared, 42.5; macadamized, 35.4; paved roadways, 3.84; planked roadways, 12; sidewalks made, 117.83; street car lines, double track, 4.57; street car lines, single track, 6.02; single track interurban railway, 4.7; double track interurban railway, 2.08; wooden box drains and culverts, 13.14; sewers laid, .15; storm sewers laid, 2.5; concrete curb only laid, .24. Main Street is now being paved with wood blocks on 6-in. concrete base to the extent of 32,500 square yards, at a cost of $3.33 per square yard, including excavation. Estimates are being prepared with a view to obtaining a water supply of 3,000,000 gallons a day from the city of Vancouver, or as an alternative, inaugurating a water supply scheme from Seymour Creek, where the Water Board of the B. C. Government have alotted them 550 miners' inches. At the present time, a steel storage tank, 75 ft. high and 50 ft. in diameter, is being constructed at Central Park at a cost of $30,000. The sewerage system will be included in the Burrard Peninsula Joint Sewerage Scheme, comprising the city of Vancouver and the municipalities of South Vancouver, Point Grey and Burnaby. Plans, specifications, etc., are in course of preparation for the sewerage scheme. The Board of Health has under consideration the installation of a garbage incinerator.

Vancouver, B.C.

This city, which has an area of 16.89 square miles, was incorporated in 1886. The population is 122,000, an increase of 43,000 in the last five years, during which period the assessment has increased from $73,000,000 to $227,000,000. The 1913 tax rate was 20 mills. The value of building permits for 1909 was seven and a half million dollars, while the 1914 estimate for building work is $10,000,000. The engineering expenditure five years ago was $2,000,000—about half the estimated outlay for 1914. The city has 51,479 miles of permanent pavements of the following classes: asphaltic concrete, bitulithic, sheet asphaltic, treated wood block, granitoid, Hassam, concrete and vitrified brick. In addition there are 171 miles of macadam streets and lanes and also in the more recently settled portions there are many miles of planked roadways, this class of construction being adopted as the cheapest and quickest method of giving access to property. At the present time there are 201.78

miles of cement concrete sidewalks in the city. Upwards of 30 miles of macadam streets are annually oiled to mitigate the dust nuisance, this practice ensuring first-class thoroughfares for motor traffic. In addition to the old type pressure flushers, two 8-ton 1,200-gallon flushers were put in service last year, thus allowing for the daily flushing of all permanent pavements. During the present year there will be an expenditure of $1,320,000 on road work, this amount being apportioned as follows: pavements, $800,000; cement sidewalks, $100,000; grading, planking, etc., $350,000; and general improvements, $70,000. A combined system of sewerage is employed, the sewage discharging into the sea. To date the total mileage of sewers is 170. In the last few years large storm water sewers of the horse-shoe type have been constructed. The largest has a width of 11 ft. 4 in. and a height of 9 ft. 1 in. Last year the provincial government passed a special act for the purpose of forming a Joint Sewerage Commission, under whose authority all future construction of trunk sewers will be carried out. This Commission has jurisdiction over Vancouver city, and the municipalities of Point Grey and South Vancouver. During 1914 the sewerage extensions planned will involve an expenditure of $2,000,000, in addition to the large construction work to be undertaken by the Joint Commission. The city operates two large incinerators for the burning of garbage, the garbage and ashes being handled separately, the latter being dumped. The water supply is brought by gravity from Capilano and Seymour Creeks, both glacier-fed streams. The Vancouver water supply is brought across Burrard Inlet by means of six 12-in. pipes, 1,600 ft. long; one 18-in. pipe, 2,200 ft. long, and five 18-in. pipes, 1,100 ft. long—all of the cast-iron flexible type. These are laid on the bed of the Inlet, the lengths given being of the submerged portions. Last year the city gave to the Canadian Northern Pacific Railway that portion of False Creek known as the City Reserve. On this land is to be erected the Pacific terminal of the Canadian Northern Transcontinental Railway. The passenger station, with necessary offices, will cost not less than $1,000,000, while the total expenditure will be some $4,000,000, exclusive of hotel. Provision is made for the establishment and maintenance of deep water wharfage and facilities adequate to the needs of a transcontinental railway and a trans-Pacific steamship line. The Great Northern Railway have a similar agreement with the city and work on both schemes is at present being carried out. At the present time the Canadian Pacific Railway is expending over three and a half million dollars in constructing a new terminal station and hotel. Tenders were called a few months ago for the erection of the Second Narrows bridge, which will form a link between Vancouver city and the city of North Vancouver, crossing Burrard Inlet. When erected, this bridge will connect the Pacific Great Eastern Railway with Vancouver city. The Dominion Government is proceeding with the construction of a dock on Burrard Inlet, the estimated cost being $1,250,000. Extensive dredging operations are being carried out at False Creek by the Dominion Government for the purpose of creating a deep water channel to the combined railway terminals at the head of the Creek, and a considerable amount of dredging is under way in the First Narrows, at the entrance to Burrard Inlet. Another large undertaking upon which work is advancing steadily is the Georgia-Harris Viaduct, which is being constructed of reinforced concrete (mushroom system), the amount of the contract being $455,000.

Vernon, B.C.

This town, or rather city—every town in British Columbia being a city—was incorporated in 1892 and now has a population of 4,000, an increase of 1,500 in the last five years. The 1914 assessment is rather more than four millions, as compared with one-and-a-half millions in 1909. The estimate for building work this year is, roughly, $1,500,000, and for engineering work $8,000—considerably more than double the corresponding expenditures five years ago. The 1914 tax rate is six mills. Vernon has a roadway mileage of 78, of which five are macadamized and 73 are gravelled. The sum of $10,000 will be expended on roadwork this season Sewage disposal is by septic tank and Stoddart percolating filter. The sewerage extensions planned comprise storm sewers, with addition to the disposal works, the whole costing $65,000. Garbage is collected by teams and deposited on a nuisance ground. The water supply is from a creek and is distributed through twenty-eight miles of mains (cast iron, steel and wood). There are two reservoirs having a capacity of 1,600,000 and 5,000,000 gallons respectively. Extensions to the electric light system are planned at a cost of $50,000.

Victoria, B.C.

This city, whose present population of 50,000 has more than doubled in the last five years, and whose assessment of $115,960,000 has quadrupled in the same period, received its charter in 1862. The value of building work in 1909 was rather less than $2,000,000, in 1912 $8,200,000, and in 1913 $4,000,000. The expenditure on engineering enterprises in 1909 was a little less than $700,000, while the estimated outlay for 1914 was $2,900,000, inclusive of the Sooke Lake water scheme. The roadway mileage is 146, classification being given as follows: unimproved, 79¾; asphalt, 47½; wood block, 3½; concrete pavement, ¾; boulevard, 57; macadam, 12½; tar macadam, 1½; vitrified block pavement, ½; concrete sidewalk, 123. The city is continuing the practice of carrying out its own sidewalk construction and has decided this year to do all grading, construction of curbs, gutters, and laying of concrete base by day labor, letting the contract for the laying of sheet asphalt. Next year, however, it is the intention to erect an asphalt plant so that all paving work will be carried out by the city. With the exception of building construction very little municipal work is let by contract. The sewerage is the high level gravity system, the low level sewage being pumped to high level and syphoned across to gravity outfall. The sewage is discharged into tidal waters. In this department the extensions planned this year will cost $480,000. All sewer construction work is done by the city by day labor. In this connection rapid progress is being made on the construction of the northwest trunk sewer system, the completion of which will drain an area of about 425 acres in the residential section of the city, as well as 1,000 acres in Esquimalt and 800 acres in Saanich. This work will involve an expenditure of $390,000, a feature of the scheme being heavy tunnelling work to the extent of 7,250 ft. through solid rock, and 3,100 feet of trenching, much of which is also through rock. The sewer will be constructed of reinforced concrete pipe, varying in diameter from 27-in. at the start to 36-in. at the outlet, the pipe being manufactured in 5-ft. lengths. Garbage is collected in dump carts and delivered to sub-stations, re-collected by motor truck, dumped on scows, and towed to sea under contract. The city's water supply is obtained from the Esquimalt waterworks. The Sooke Lake dam, Humpback reservoir, and grading and concrete trestles for flow line were constructed by the city and the contract let to the Pacific Lock Joint Pipe Company for the manufacture and laying of reinforced concrete pipe for flow line. The contract was also let to the Burrard Engineering Company for the construction of the rivetted steel pressure line from Humpback reservoir to the city, all trenching and back-filling on the latter to be done by the city. This scheme, the estimated cost of which is about $3,000,000, is in process of completion Extensions to the city mains will be made this season at a cost of $50,000.

Owing to the shortness of time, all parts of the work were carried on simultaneously. [Swift Current Storage Dam]

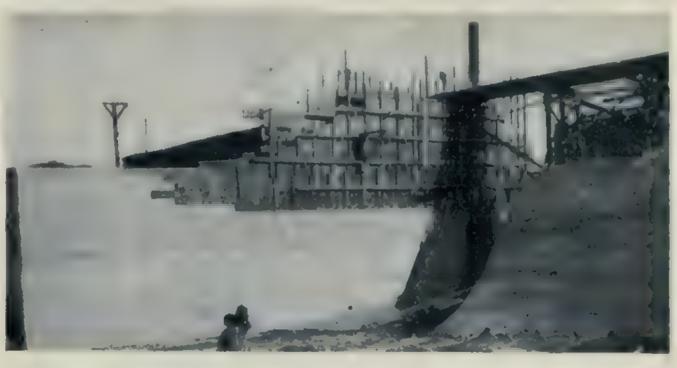
Reinforced Concrete Storage Dam at Swift Current, Sask.

By W. F. Farley[*]

IN the winter of 1912 the water supply at Swift Current, Sask., failed completely, owing to the freezing of the Swift Current Creek from which the supply was obtained. In order to prevent a recurrence of such a catastrophe, the Swift Current officials decided that it was absolutely essential that a reliable water supply should be secured before the coming of another winter.

As Swift Current Creek is the only available source of supply in the immediate vicinity, the problem resolved itself into damming this creek and forming a reservoir of sufficient capacity to tide over the comparatively short period during which it might be possible for such a condition to recur. The foundations throughout the length of this creek are suitable only for the construction of a hollow dam, and as the city was desirous of obtaining a permanent structure, it was decided, after considerable preliminary investigation, to use the Ambursen type of spillway, together with corewalls and earth embankments at either end. A design for such a dam was therefore prepared by the Ambursen Hydraulic Construction Company of Canada, Limited, in conjunction with the city officials.

No reliable data regarding the maximum flow of the stream was available. It was necessary, therefore, to provide a large factor of safety for the discharge capacity of the dam. At either end of the spillway section the earth embankment is retained by means of a cantilever retaining wall of reinforced concrete construction. At one end of the spillway section an intake is provided within which the water passes alternately through coarse trash racks and fine copper screens before it enters the pipe leading to the pumping station. Gate valves provide for the absolute control of the water as it enters the pipe, these gate valves being controlled from a gate house placed directly over the intake.



Considerable care was taken in providing for proper concrete surfaces.

The results of borings indicated the necessity for the excavation of a considerable amount of material, in order to obtain a suitable foundation for the spillway. Cut-offs are provided around the area occupied by this spillway and also under the concrete corewalls

Concrete was placed by means of a derrick with the aid of chutes and cars.

---

[*] Assistant Engineer, Ambursen Hydraulic Construction Company of Canada, Limited.

Reinforced Concrefe Storage Dam at Swift Current, Sask.

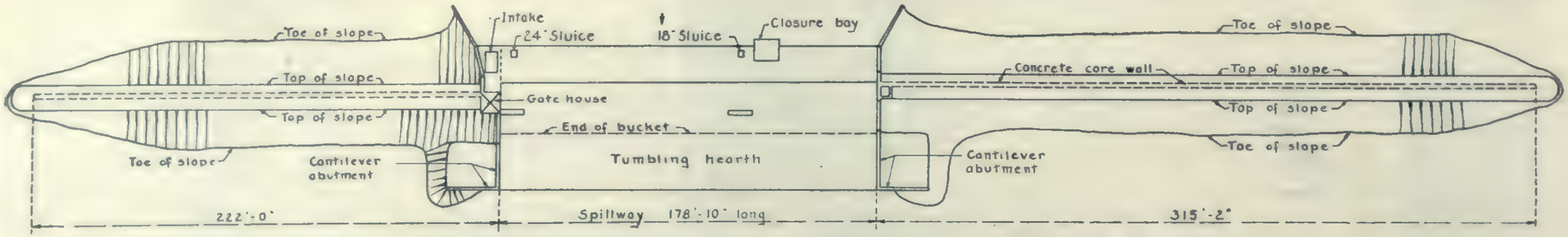
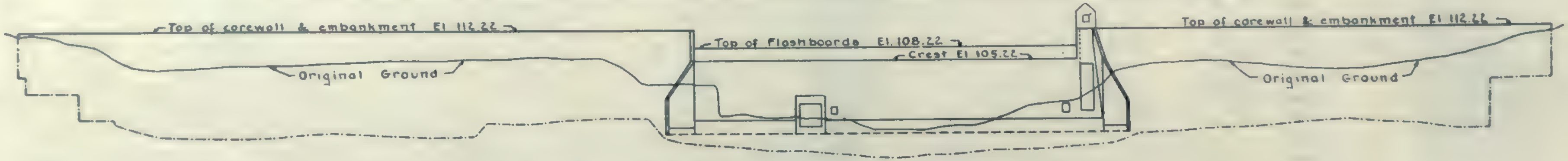


Fig. 1—The dam consists of reinforced concrete spillway, on either end of which there is a concrete core-wall and earth embankment.


Top of corewall & embankment El 112.22
Original Ground
Top of Flashboards El. 108.22
Crest El 105.22
Top of corewall & embankment El 112.22
Original Ground

Fig' 2—Flashboards provide for an increase of 3 ft. in normal level of reservoir.

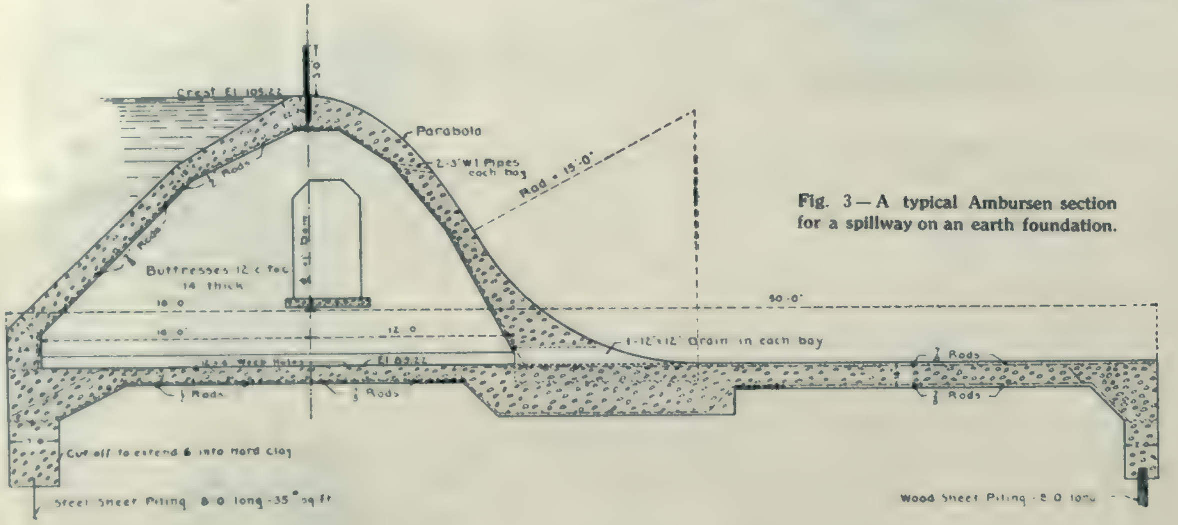

Crest El 105.22
Parabola
2-3" W.I. Pipes each bay
Rod = 15'-0"
Rods
Rods
Buttresses 12' c toc. 14" thick
℄ of Dam
18'0"
18'0"
12'0"
50'-0"
1-12"x12" Drain in each bay
El 89.22
Rods
Rods
Rods
Rods
Cut off to extend 6' into hard clay
Steel Sheet Piling 8'0" long -35# sq ft
Wood Sheet Piling - 8'0" long

Fig. 3—A typical Ambursen section for a spillway on an earth foundation.

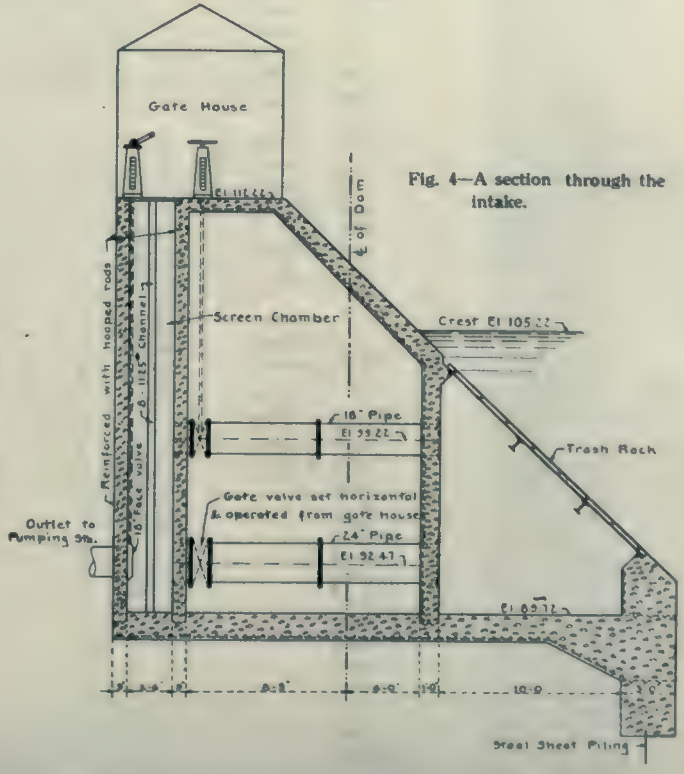


Fig. 4—A section through the intake.

The flow of the creek was handled by means of a small wooden flume. [Swift Current Storage Dam]

at either end. These cut-offs consist of concrete to a depth of 6 inches below the surface of a blue clay substratum. Into this blue clay was driven sheet piling to further diminish the possibility of seepage beneath the dam. A tumbling hearth is provided of sufficient length to prevent any possibility of scour due to the passage of the flood water over the dam.

Owing to the financial stringency during the summer of 1913, the city officials found it impossible to secure the necessary funds for the construction of this dam until late in the summer. Finally they succeeded in their efforts, however, and construction was commenced by the aforesaid company during the first week in August.

The time factor involved was largely instrumental in deciding the question of the proper plant to be used on this work. This problem was solved very successfully by the shipment of a Guy derrick, mixer, pumps, boilers, etc., which had just been thrown out of employment by the temporary closing down of construction work at LaColle Falls, near Prince Albert, Sask. This plant arrived on the site on the 20th of August and was put into operation as soon as possible.

The cofferdam problem was solved very easily by means of a small "A"-frame dam, constructed of timber and toe-filled with part of the material excavated from the site of the dam. This cofferdam was pumped out for the first time on August 23rd, thus preparing the way for the excavation in the middle of the creek. The excavation was started on August 26th.

The first concrete was poured in the cut-off trenches on September 25th, and from that time on the dam grew day by day until the 3,500 cu. yds. of concrete had been placed. The dam was finally closed on December 23rd and the water allowed to collect behind it. On December 24th the dam was officially turned over to the city.

The Efficiency of Water-Works Devices*

By E. L. Loomis

MORE than four-fifths of all the water plants of the state of Indiana belong to the smaller classes, whose daily pumpages probably average less than one million gallons. As compared with the larger systems, these enterprises have relatively few consumers, limited revenues, and proportionately much higher fixed charges and operating expenditures. Therefore, it is easy to realize that of the problems confronting such utilities, those related to economy and efficiency are of paramount concern. And the smaller the utility, all the greater becomes the necessity for the closest scrutiny into its plant operations for the detection and stoppage of waste, and for the economical conduct of its affairs generally.

So many and varied are the equipments available now-a-days which make for economy that to undertake a minute enumeration and description of them all would much overstep the requirements of this report, not to mention the writer's lack of knowledge as to so wide a range. Only a few items, therefore, will be here considered, chief of which may be cited the pumping machine.

As illustrating an experience in pumping economy you will permit me to state the conditions as existing in our plant at Valparaiso, and to make a comparison of the costs of operating each of our three different types of pumps.

Our pumpage approximates one million gallons per day, pumping direct against a total head of 85 feet. Our principal pump for continuous operations is a cross-compound, condensing engine, with Meyer gear and attached air pumps. Upon acceptance test when we purchased this machine two years ago it showed a duty of 78.57 million foot pounds per 1,000 pounds of steam used, pumping against our usual head at normal load.

Assuming an apparent evaporation of seven pounds of water to each pound of coal, and a total head of 100 feet, with a working duty of about seventy million foot pounds per 1,000 pounds of steam, this machine will pump and deliver one million gallons of water each day for one month at a steam consumption of 358,071 pounds, thus requiring 25.57 tons of coal, which, at

---

*Abstracts from paper before Indiana Sanitary and Water Supply Association.

$3.50 per ton in bin, costs us $89.49. With our No. 2 reserve pump, of the non-compound, condensing, crank and fly-wheel type, assuming a working duty of only fifty million foot pounds, which really is a trifle too high, for the same pumping operation, 501,300 pounds of steam would be consumed, requiring 35.80 tons a coal at a cost of $124.30. With our third unit, a simple duplex pump, which, needless to state, is rarely placed in service, 752,129 pounds of steam would be used, or 53.71 tons of coal, costing us $187.98.

Thus is it observed that by using our No. 1 pump, for each month we operate, we show a saving of $34.81 over pump No. 2, while over pump No. 3 we effect a saving of $98.49, or in round numbers at the rate of almost $1,200 per year.

Such a saving to any small plant in a comparatively short time would be sufficient to buy and install the very best and most economical type of pump which the market affords.

In our own case it is plainly apparent that from the standpoint of even ordinary business economy we had better consign both of our low duty pumps to the scrap-pile rather than place them in continuous operation. As auxiliary units, for temporary emergency purposes, however, they, of course, have their proper place and value.

The pumping machine for every plant should be designed so as to give the best possible economy at the normal load, but with ample capacity for the maximum requirements, such as the sudden opening of large connections, or where direct fire pressure is furnished at the hydrant nozzle. In most all cases operating economy should be considered in making a selection rather than first cost. But the fixed charges on a high duty machine of the Corliss type, by reason of its higher first cost, the greater housing space required and its many complications, may sometimes more than counterbalance the saving over a simpler type, such as the Meyer gear.

The kind of boilers, the character of fuel, and methods of firing are all-important questions in considering boiler room economies. For every plant the boilers should be in duplicate units, and, like the pumps, of ample capacity for the peak load, though not too large for the normal uses. As safeguards, the steam lines from the boilers to each pumping unit should be as nearly separate as possible. Obviously also should the boiler feed-water system be entirely separate and independent.

In determining the kind of coal to be used it has been our experience that dependence should not be placed upon the basis of heat units alone, but that the coals should be tried out, not merely for a few days under the most favorable firing conditions, but thoroughly tested under the every-day working conditions just as they actually exist. Under such test, the coal evaporating the most water for the dollar manifestly should be the kind to adopt. Moreover, with propriety, and sometimes with profit as well, coal bought on contract may be tested from time to time as a check upon its continued good quality. For this purpose where the amount consumed will not warrant the purchase of a good bomb calorimeter, the lead oxide reduction method may be used, such an outfit costing but a few dollars and the results being sufficiently satisfactory for purposes of comparison.

Where the coal storage room is located adjacent to railroad siding, if used in quantities sufficient to justify, coal conveying machinery may effect a substantial saving over the usual hand operations.

As aids in the work of full conservation, involving, as it does, one of the most conspicuous items in operating costs, the best patterns of shaker and dumping grates, and also automatic damper regulators, may be used with profit. If the amount of coal consumed will not justify the purchase of a CO_2 recorder, a boiler efficiency meter with Orsat apparatus will be found to furnish a valuable guide.

Steam flow meters may be had at small cost for attachment to the different steam lines, and when installed will furnish desirable information as to the amount of steam conveyed to the different units or heating systems. Another device of value, though of much greater cost, is the Venturi meter, which, if placed on the pump discharge line as a check on the engine counter, will often reveal unsuspected pump slippages needing correction.

A common and often unconsidered source of loss in many small plants is leaky valves. A valve reseating machine should be in every power house and by its use every valve kept always in proper repair. Suitable equipments for the various repairs common to all plants from time to time are not only necessary but money-saving assets in times of their need.

Oiling arrangements frequently are not given the attention which their importance would seem to deserve. The system employed should be such that the oils may be saved, refiltered and used again. With such saving they may be used more freely than otherwise, thus safeguarding against hot bearings from time to time, with their consequent annoyance, or possible interruption to the service.

In connection with the operation of filtration systems, a good serviceable laboratory would seem to be indispensable for the necessary tests. Cities without such systems and having water at times of questionable quality will find apparatus for the use of hypochlorite of lime to be an inexpensive as well as most valuable acquisition.

By the use of steam and water pressure recording gauges, if supplemented with accurate hourly notations of coal consumed and water pumped, the engineer and manager are afforded definite knowledge concerning the workings of the plant, and also furnished a permanent record of the same.

So well known is the value of the water meter that it would seem to be superfluous to make mention of it here. And yet the fact remains that in Indiana there are a number of plants operating almost, if not entirely, upon flat-rate bases. As a conserver of water this device is second to none, and its value is closely followed by the meter testing machine. For leakage inspections the detectorphone and pitometer are both widely recommended.

For the office there are many devices worthy of adoption and use, such as the adding machine, the typewriter, addressograph, card indexes, filing apparatus, loose-leaf systems, etc. An accurate map showing definitely the location of all mains, valves and sevice boxes is of inestimable value and should be deemed an indispensable part of every system. A few well-selected technical books and the best waterworks journals will prove to be not only sources of information and pleasure, but of actual profit as well. For articles of especial interest, should one wish to dispense with indexes, a scrap-book might be used to good purpose.

Building Construction in Nova Scotia

Not a Wealthy Province But One With a Future—Antiquated By-laws in Force—Structural Character of the Buildings Now Being Erected

By a Halifax Correspondent of the Contract Record

NOVA Scotia is one of the oldest provinces of the Dominion and perhaps the most backward in the matter of building construction. The authority for this statement is a fair knowledge of what has taken place in building during the last twenty years. Buildings are constructed because of necessity, brought about by various conditions such as increase in population, industrial expansion and fire. Man needs shelter for his family, the manufacturer a place to manufacture his goods, the community a place wherein to worship, and so on.

In industrial development Nova Scotia has never experienced a great boom. There have been one or two flurries in different parts of the province but nothing of a general nature. Her growth has been slow, but perhaps steady. Confederation threw cold water on her prosperity. Since then the call of the west has made great demands on her population. This is demonstrated in the fact that during the last two years Halifax has increased in population only 5,787. Situated as we are on the Atlantic Coast, that is, on the edge of the continent, we are in a poor position for manufacturing, and whilst we are proud of the plants we do possess, they are few and far between. Necessity for building, therefore, has been limited.

There is very little wealth in Nova Scotia. Nothing stamps itself on a country in such a decided manner as does the comparative wealth of its inhabitants. Man builds himself a home, accumulates money, tears the old home down and builds anew. A man is prosperous in business and his premises are significant of the fact, sometimes in size, sometimes in decorative features. A group of men enjoying prosperity join in the erection of a more beautiful church, the community grows and demands a theatre and so on. It happens that we have few fine homes in our entire province—indeed comparatively few costing over $20,000. Our places of business are usually old, and many progressive and well-established firms are doing business in frame buildings. Our churches are ordinary, both as regards exterior and interior, and a great majority are of wood. There is not a modern theatre building in Nova Scotia. Not only is there little wealth in Nova Scotia with which to build, but building itself is high and our standard of workmanship is low. Here the mechanic does a small day's work at a high wage. What do you think of the bricklayer setting up two hundred and fifty bricks a day? I have positive information from two of our contractors that this actually constituted a day's work for certain bricklayers under their employ. This condition hinders building in general and the adoption of better types in particular. The writer has frequently found difficulty in convincing Upper Canadian clients that certain work has been executed by our best men and that the price is not exorbitant, considering the above conditions.

Our building laws are defective. They are not revised so as to keep pace with structural developments, nor are they progressive in the matter of demanding higher and newer ideals. They do not give protection to the individual. You may buy a block of land in Halifax for the purpose of developing a housing scheme, for instance, without any assurance on the part of our building laws that your next door neighbor may buy the adjoining block for factory purposes, or for tenements of the cheapest kind. There is only one street, and a short one at that, where one can go with safety and even here the minimum cost for a home is $5,000. Probably one reason why our building laws are not in a sufficiently revised state is that Halifax has never suffered from fire and her citizens therefore are not afraid of it. You will find the residential portions of our city almost entirely frame, whilst the commercial districts are a strange mixture of wood, brick and stone. Some of our largest hotels and picture theatres are of wood and a constant menace to life. Some day we will be burned out and then our building laws will be revised, demanding the best there is in construction and encouraging development in all its phases. This is the old story of erecting a fence after someone has fallen over the ditch.

It seems singular, too, that such conditions should exist when our province is so amply supplied with building materials. Our timber is exported to all parts of the globe. Our freestone is finding a good market in the upper provinces. Our granite cannot be beaten for quality and texture, and we are at present manufacturing brick which not only compares favorably with those manufactured in other parts of Canada, but we were given first place over Upper Canadian brick at a recent exhibition. We have sand and gravel for concrete work which tests very high, even running a very close race with broken stone for results.

Better Days in Store for Nova Scotia

We are hopeful, however, that a better day is dawning for our city. At present foreign capital is knocking at our doors asking for the opportunity of developing waterways outside our city, so as to bring in cheap power for the purpose of attracting manufacturing plants. A year ago outside capitalists, realizing the possibility of expansion in this territory and the scarcity of property in the small peninsular on which we are built, purchased vast quantities, both suburban and commercial, with the result that our real estate values have been greatly raised. The terminal works which have been started by the Dominion government are bound to revolutionize the life of our city. The facilities for shipping which will be thus afforded will be unsurpassed on the Atlantic Coast and cannot fail to attract steamship lines to our port, thus making us the so-called "Gateway of the Dominion." We are hoping that this will apply not only to passenger traffic but that a great freight trade will also result. The Dominion government is also contemplating, and we have been given to understand have decided upon, the erection of a new dry dock such as will accommodate the largest ship afloat. We were informed not long ago that British capital was being interested in the matter of a ship building plant, locomotive works, and other industrial enterprises for our city. If half these good things could only be realized we would be more than satisfied, for our city would then awake from its slumbers, new blood and fresh life would be enthused in its veins and Halifax would eventually become, as we had hoped some day it would become, the "New York of Canada."

To enumerate a few of the buildings recently erected and in course of construction I may say that in Halifax a new Y. M. C. A. building and a new branch office for the Merchants Bank of Canada have terra cotta fronts, reinforced concrete walls and floor. These are the only buildings in Halifax containing any terra cotta and it is possible that had these been designed by local architects we would still be without a terra cotta example. Ours is a most severe climate and our faith in this material has yet to be established. The Canadian Bank of Commerce recently built a new branch office, using what we call Terrance Bay granite for the fronts, with floors of steel and concrete. This granite is very white and of coarse texture, and makes an imposing facade for buildings of a monumental type. This quarry is some fifteen or twenty miles from Halifax and because of this fact and the weight of the material, the stone figures high in cost. Moir's Limited, manufacturers of bread, etc., have just finished two eight-storey factory buildings and a two-storey stable, all in reinforced concrete as regards floors, whilst one of the factory buildings and the stable have brick curtain walls. The Acadia Sugar Refinery Company are building a large plant across the harbor, using brick walls, steel and concrete floors. In connection with this plant is a chimney 250-ft. high, built of radial brick.

Dalhousie University has undertaken the erection of new buildings, and for their Science building they have adopted the rather strange scheme for the walls of iron stone facing, backed up with granite followed by an air space and an inner brick wall. Cragg Bros., Limited, last year built new premises, using reinforced concrete floors and brick curtain walls, making the only fireproof commercial building in the city. The Dennis office building, finished last summer, has four storeys of Shelburne granite, which is very fine in texture, similar to the Stanstead, and three storeys of brick with steel and concrete floors, making the only fireproof building we have that is devoted entirely to office purposes. The Dominion government during the last five years have erected a new Customs House, built with freestone walls and steel and concrete floors. Besides this they have remodelled the old Post Office, removing the old wooden floors and substituting steel and concrete. Our school buildings, always a matter of interest, have added nothing of importance in the way of development. Whether large or small they continue not to be fireproof, the larger ones being of brick generally, with frame floors. However they have the redeeming feature of plenty of exits. Within the last six years we have built three school buildings with separate entrances, etc., to comply with the requirements of the School Board. These buildings may not be firetraps but certainly they are not fireproof. The local government some two or three years ago built a large Technical College with brick walls, steel and concrete floors. The city council are at present building a large reservoir entirely of reinforced concrete, and also a public market building, the walls of which are reinforced concrete to the spring of the window arches, the balance being of brick. So we might go on enumerating the various buildings of importance. It will be found that apart from wooden buildings brick predominates with wooden floors. Fireproof work is rather scarce and reinforced concrete seems to be obtaining a strong footing.

Drill Boat for Submarine Blasting at Vancouver, B. C.

A pier in Burrard Inlet, Vancouver harbor, is to be built for the Canadian Government, and the contract for this has been let to Henry, McFee & McDonald, of Vancouver, B.C. It includes 150,000 cubic yards of rock excavation to a maximum depth of 51 feet below high water. The present depth of water at the site is from 10 ft. at the shore end to nearly 50 ft. at the outer end, so that the thickness of rock to be removed ranges from a few feet at the outer end to over 40 ft. near the shore end. The maximum depth of drilling will be about 53 feet below high water. The tidal range is about 15 feet.

For this work, the contractors have had built a large drill boat which is said to be the first of its kind on the Pacific Coast. It was designed by A. F. Woolley, consulting engineer, of Vancouver, and the hull was built and equipped at that place under the direction of Mr. Woolley and Mr. Odell, manager for the contracting firm.

The hull is 118 x 30 ft., and 8½ ft. deep, with Oregon pine planking 6 in. thick for the sides, 5 in. for the bottom and 4 in. for the deck. There are four bulkheads of timbers 12 x 6 in. For pulling the boat off and on the range line and getting it into position, there is an anchor and cable at each corner, the cables being handled together or independently by means of a pair of double-drum engines, having two cylinders 6½ x 8½ in. The machinery equipment is mounted in a large deck house, and includes two boilers 5 x 14 ft., a 7500-gal. tank for fuel oil, a 5000-gal. tank for feed water, two oil-feed pumps for the furnaces, two feed-water pumps, and a small steam generator unit for electric lighting. There are also two pressure pumps, one of which supplies the water jets at the drills. The second can be used for the same purpose but is used ordinarily for pumping oil from a barge to the storage tank, and this pump is also connected directly to the pipe lines for fire purposes.

Along one side of the hull are five drill towers, of steel construction, 47 ft. high from the deck. They are mounted on shoes consisting of pieces of inverted 80-lb. rails, the rail heads sliding in channels on timber stringers. The shoes are staggered slightly on alternate towers, so that they will telescope in the channels, thus enabling the towers to be placed close enough to drill holes 5½ ft. c. to c. Heavy setscrews clamp the shoes to the channels while the drill is at work. Each tower has a two-cylinder double-drum hoisting engine which moves the tower by means of a cable which can be hooked to a U-bolt in the deck and led over a sheave to the drum or winch head.

The drills are of the Sullivan submarine pattern, with cylinders 5 x 8½ in. and extension guides for the piston rods. They can drill holes 40 to 50 ft. deep, and on this work the holes will be 3 in. diameter, but the drills can drive holes 2 to 5 in. in diameter. Each drill requires about 18 h.p. for operation. It weighs about 980 lbs., while its mounting weighs about 2,000 lb. The drill is bolted to a heavy casting or recoil block, having a sheave at the top for the hoisting cable.

which passes over double sheaves at the top of the tower.

A feature of the mechanism is a cushion valve which prevents the piston from striking either end of the cylinder when working with throttle wide open. This permits the machine to run practically at full speed in starting a hole in broken rock or on a sloping surface, and also aids in restoring a deflected hole to proper alignment. This valve may be used also in pumping out a hole that has become filled with mud before loading. Steam at 120-lb. pressure is supplied to the drill through 1½-in. pipe with telescopic joints.

At each corner of the hull is a 72-ft. timber spud, 30 in. square, with cast-iron shoe. On the top of the spud is a 30-in. sheave, and on its outer face (about 15 ft. above the deck) is a steel grip to which the ends of the two spud cables are attached. Each spud has a two-cylinder double-drum engine. One cable is led under a deck sheave, up the back of the spud to the top sheave and then down the front side to the grip or attachment. The other cable passes from a deck sheave down to a sheave on the side of the spud and then up to the grip. The cables are attached to opposite ends of the drum, so that as one is hauled in the other is paid out. The cables are long enough to bring the spuds to a bottom bearing in 52 feet of water.

Thermal Properties of Concrete

A paper read by Professor Charles L. Norton, to the American Society of Mechanical Engineers, gives a useful summary of the results obtained by a series of experiments carried on at the Massachusetts Institute of Technology during the past four or five years. The main object of the investigation, which is not yet completed, is to collect data bearing upon the physical properties of Portland cement concrete as a fire-resisting material. In the following notes we state the principal results in condensed form for convenient reference:—

Coefficient of Linear Expansion.—Table 1 gives the average values for a large number of specimens tested.

TableI.—Coefficient of Linear Expansion of Concrete

Temperature. Deg. Fahr.	Coefficient of Expansion. Per unit of length per deg. Fahr.
72 to 360	0.0000045 to 0.0000060
72 to 750	0.0000050 to 0.0000060
72 to 1,090	0.0000045 to 0.0000050
72 to 1,600	0.0000035 to 0.0000042

The value at low temperatures agree fairly with the generally-accepted value of 0.0000055 for the unit elongation per deg. Fahr. A considerable number of tests demonstrated the fact that the expansion depended more upon the temperature of the outer surface than upon the average temperature of the specimens. Therefore Professor Norton concludes that in reinforced concrete at high temperatures, as in case of fire, the divergence of the coefficients for concrete and steel is not a serious matter, since the metal reinforcement and the concrete surface are not at the same temperature.

Diminution of Strength after Heating.—Tests conducted on small cubes showed that the losses of strength due to exposure for two hours to temperatures of 900 deg. and 1,700 deg. Fahr. were 15 per cent. and from 50 to 65 per cent. respectively. It should be noted, however, that owing to the small dimensions of the cubes and to the fact that they were entirely surrounded by flames, the results are not applicable to concrete as employed in actual construction. Some tests were also carried out on small beams, but, as Professor Norton remarks, they were not very helpful in giving information concerning the behaviour of full-sized beams in buildings, and except as giving information concerning different mixtures of concrete the results are of very little value.

Specific Heat.—Table 2 gives the specific heat for three mixtures of concrete, as determined by Professor Norton. As the specific heat of a body denotes the number of thermal units necessary to raise the temperature of 1 lb. of the body 1 deg. Fahr., this factor is of importance in connection with the warming of buildings as well as with their resistance to fire.

Table 2.—Specific Heat of Concrete

Temperature	Stone Concrete		Cinder Concrete
	1:2:5	1:2:4	1:2:4
Deg. Fahr.			
72 to 212	0.156	0.154	——
72 to 372	0.192	0.190	0.180
72 to 1,172	0.201	0.210	0.206
72 to 1,472	0.219	0.214	0.218

Heat Conductivity.—Apart from its importance in all questions connected with the protection of steelwork and steel employed as reinforcement, the thermal conductivity of concrete directly affects problems in warming practice and the comfort of buildings in which concrete is employed as a structural material. Table 3 gives results ascertained by Professor Norton.

Table 3.—Heat Conductivity of Concrete

Temperature of Heated Surface	Composition of Concrete		British Thermal Units per deg. Fahr. per sq. ft. per. in. thick per 24 hours
Deg. Fahr.	Aggregate	Proportions	
95	Stone	1:2:5	150
122	Stone	1:2:4*	76 to 144
122	Cinder	1:2:4	56
392	Stone	1:2:4	146
752	Stone	1:2:4	153
932	Stone	1:2:4	160
1,832	Stone	1:2:4	188
2,012	Stone	1:2:4	202

A wire rope incline 6,000 ft. long, with two curves, is used to lower stone down Table Rock Mountain, near Boise, Idaho. The mountain rises 900 ft. above the river at its base, and on the summit is a ledge of sandstone said to be of fine quality for building purposes. Quarries have existed on this ledge for many years, and it was the difficulty in getting this stone down the mountain that led the Boise Stone Company some years ago to build the incline. Except at the bottom, where the line branches out into two two-rail tracks to allow cars to pass, the incline is a single three-rail track, which is virtually a double track, one car running on the first and second rails and the other on the second and third—each car controlled by a single cable on rollers between its corresponding rails. Leschen plow-steel cables 1⅜-in. in diameter are used.

Mr. Cozzolino, President of the Nova Scotia Construction Company, contractors for the government pier in course of construction at the north end of Halifax harbor, stated at Montreal a few days ago that the firm had sunk 160,000 concrete piles from 56 to 78 feet in length, each weighing as much as 25 tons, and driven into the bottom of the harbor (where the water reaches a depth of 38 to 40 feet) by a hammer weighing about sixteen tons. This he regards as the solution of the concrete pier problem, a matter which has been discussed by engineers and contractors for a long time. Although the work is well advanced there are 300 piles still to be driven, making a total of approximately 200,000. The cost of the work, which will be completed about August, will be in the neighborhood of $1,000,000.

Features of The Northern Electric Company's New Plant at Point St. Charles, Que.

THE position of importance as an industrial center occupied by Point St. Charles, that portion of the city of Montreal lying southward from the Lachine Canal toward the Grand Trunk Shops and the St. Lawrence River, is receiving no mean impetus from the erection of the large group of buildings now under construction for the Northern Electric Company, Limited, formerly The Imperial Wire & Cable Company, Limited, and the Northern Electric & Manufacturing Company, Limited. These buildings will, when completed, constitute what is undoubtedly one of the largest single industrial units ever built at one time in the Dominion of Canada. There are probably larger plants operating to-day, but these have been built up gradually by additions to the original buildings.

The ground covered takes in almost the entire block bounded by St. Patrick Street, Shearer, Richardson and Richmond Streets, a total area of over 178,000 sq. ft., and the floor space in the completed buildings will total over twelve acres in extent. An idea of the size of the work can be obtained from the fact that the weight of structural steel used will be approximately seven thousand tons, while the order placed with the National Fireproofing Company of Canada for tile is said to be the largest single order ever given for any industrial work in Canada other than for elevator construction.

Approaching the main entrance on Shearer Street, the two main buildings will, when completed, present a frontage of some 320 ft. in length on both Shearer and Richardson Streets, rising to a height of eight storeys above first floor level. (Figs. 1 and 1a.) A massive granite base is carried around all street frontages at a uniform level, on Richardson Street rising to a height of about 12 ft. above the sidewalk. Above this the front is of La Prairie plastic brick, laid in purple mortar with widely raked joints and trimmed with architectural terra cotta lintels, belt courses and medallions of a color to match the brick. The whole will form one of the most effective fronts presented by any manufacturing plant in Canada; the effect of the wide joint and purple mortar being to set out the brickwork and make a very striking wall.

The two main buildings have a width throughout of 60 ft. and in these alone there will be nearly 275,000 sq. ft. of available floor space. Parallel to building "B" on Shearer Street and running back from building "A" are two wings 60 ft. in width and over 300 ft. long, at present being finished to a height of four storeys only, although the foundations are designed for a future extension to the same height as the main buildings.

A layout of the property and buildings is shown in Fig. 2. The two main buildings are marked Section "A" facing on Richardson Street, and Section "B" facing on Shearer Street, while the two wings will be known as Sections "E" and "G." Light courts are provided between wings, the spaces being taken up with one storey buildings, known as Sections "D" and "F." These two buildings will have trussed roofs with I-beam purlins supporting T irons and book tile, overlaid with ready roofing. The roofs of the main buildings will also be supported on trusses and book tile carried on T irons covered with Barrett specification roofing. The future fifth floor permanent tile arches of buildings "E" and "G" will form the present roofs of these two buildings, slopes being formed with cinder concrete and covered with Barrett specification roofing.

The other buildings, shown on the block plan, Sections "H," "M," "N," "O" and "P," are of one storey, with book tile roofs covered with roofing of same specification. Sections "Q" and "R" are respectively the boiler room and turbine room.

As in all modern industrial works, particular attention has been paid to lighting and ventilating facilities, all roofs being provided with as large a measure of skylight space as possible, and sash generously provided with ventilating sec-

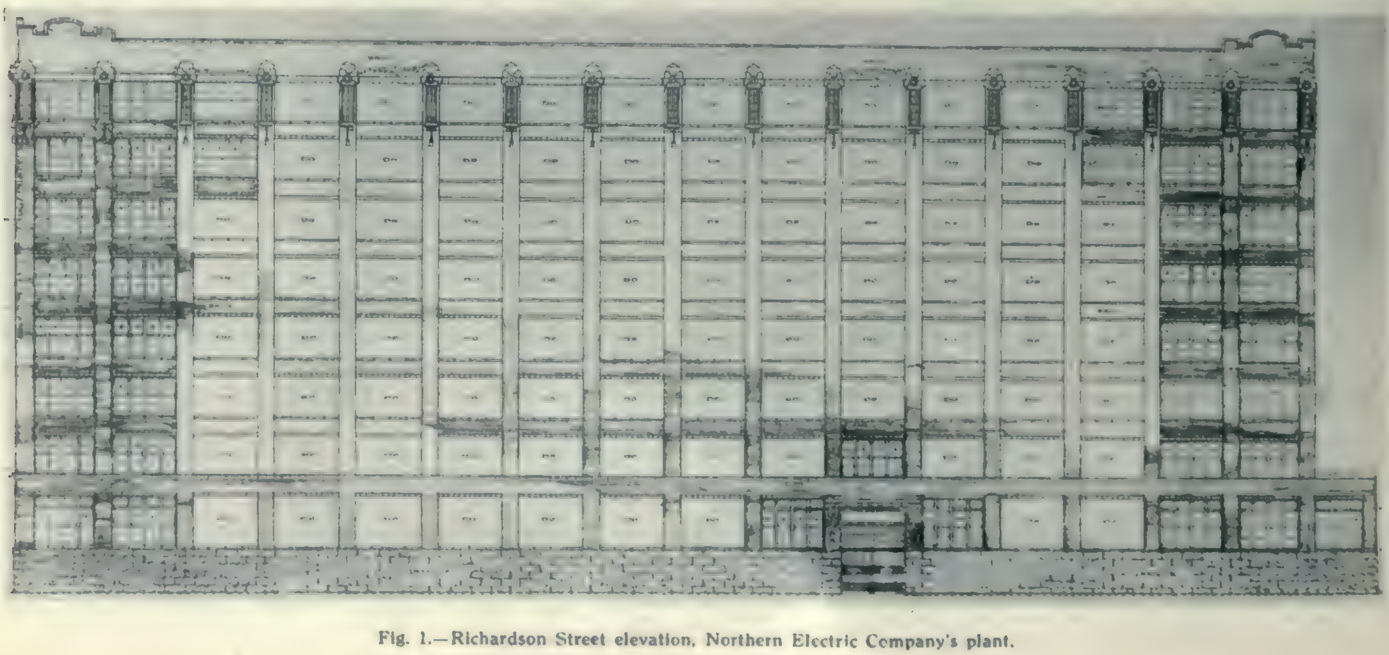


Fig. 1.—Richardson Street elevation, Northern Electric Company's plant.

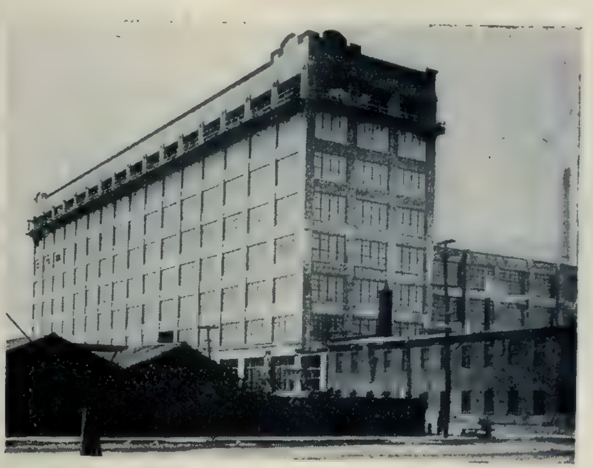
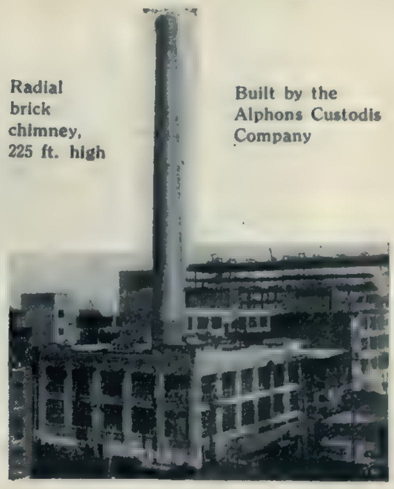


Fig. 1A.—Photographic glimpse of the Northern Electric Company's plant now nearing completion.



Radial brick chimney, 225 ft. high

Built by the Alphons Custodis Company

Fig. 3.—Power house and chimney.

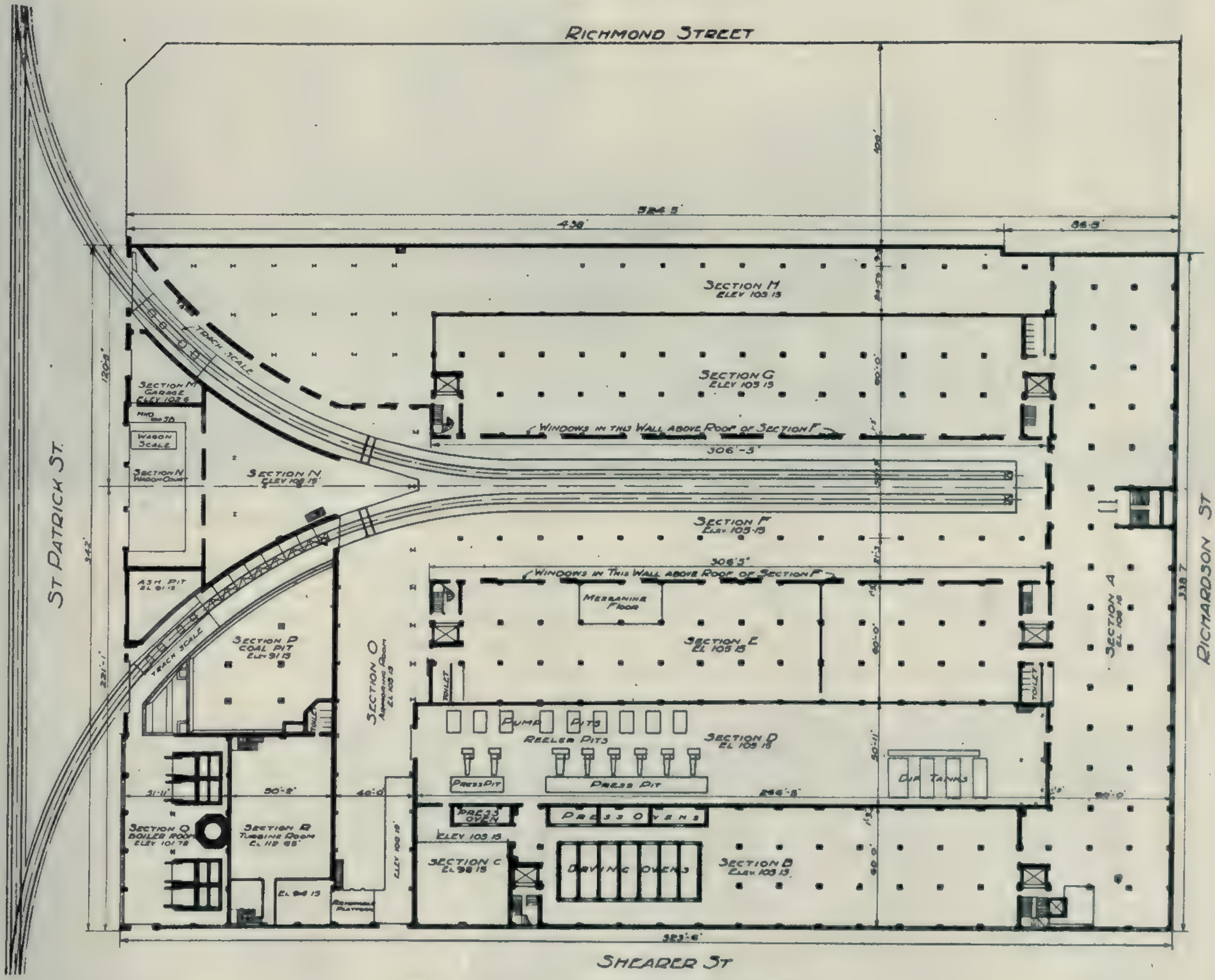


Fig. 2. General plan of the property and buildings.

New Plant of The Northern Electric Company, Limited

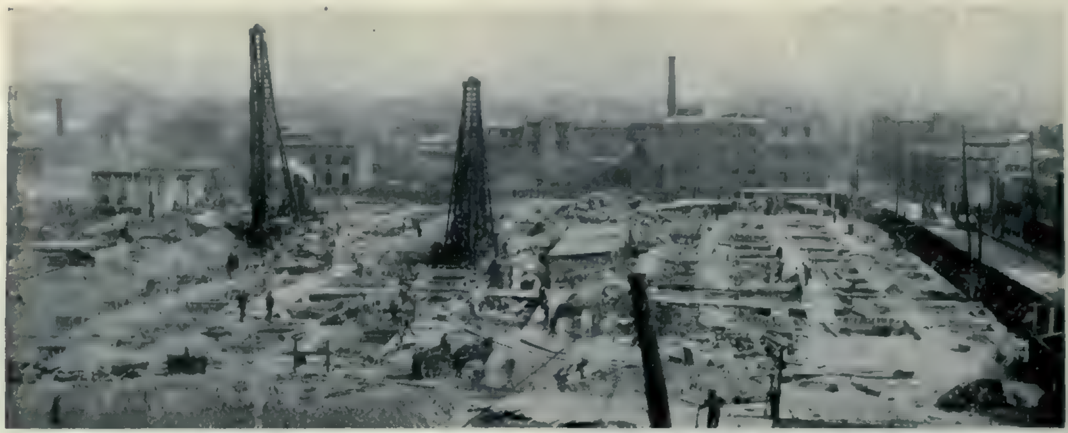


Fig. 4.—View of operations on the Northern Electric Company's plant during the progress of foundation work.

tions. Monitor skylights, with pivotted sash in the sides, are used on all roofs except those of sections "D" and "F" where flat skylights are installed. Trussed Concrete Steel Company's sash is used and occupies a large percentage of wall areas.

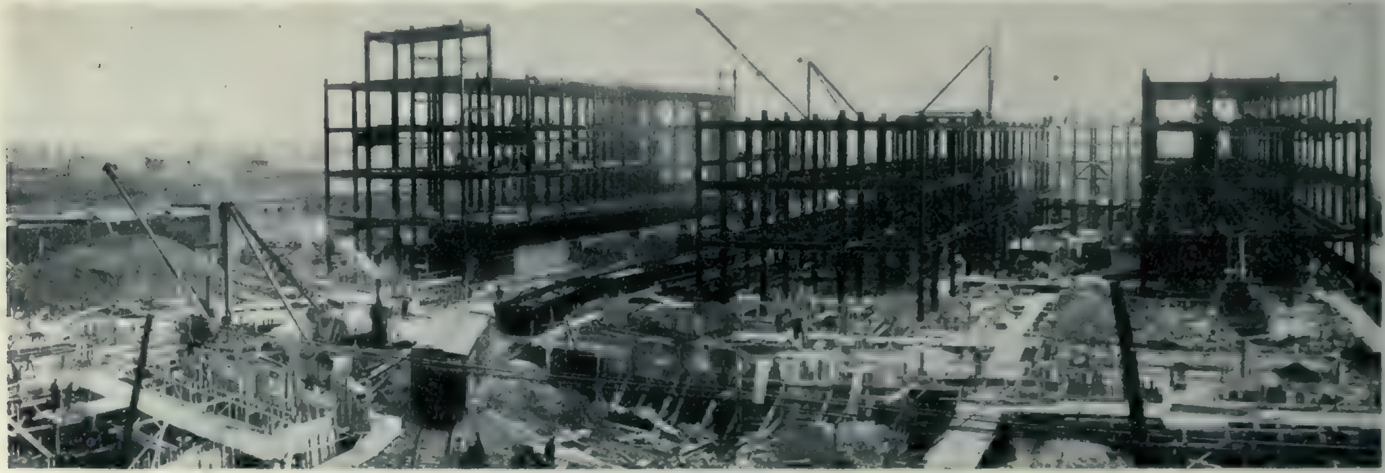


Fig. 5.—General view showing steel work of the Northern Electric Company's plant partly completed.

Shipping and receiving facilities are provided by sidings connecting both the C. P. R. and G. T. R. These tracks run the entire length of section "F" which will be used as a shipping department. Where the C. P. R. track passes through section "P" it is carried over a steel trestle with a sloping bottom, so that coal for the power plant can readily be unloaded and handled by conveying machinery, either directly to the boilers or to be stored in section "P."

The power house is designed to supply all power and heating required in the various buildings. Babcox and Wilcox boilers will be used and all generators, pumps and accessory machinery will be steam turbine driven. Exhaust steam will be used for heating the buildings, this being a forced hot water system. The chimney is one of the largest in Montreal, rising to a height of 225 ft., with a 10-ft. diameter flue and having

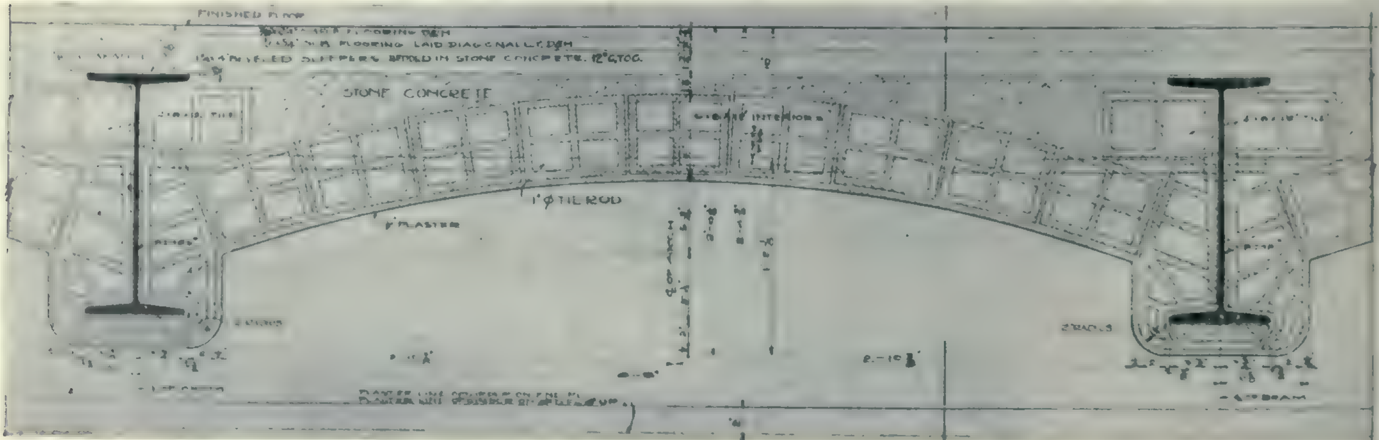


Fig. 6 (Northern Electric Company's plant).—Section through typical interior floor panel.

an exterior diameter at the base of 18 ft., decreasing to 11 ft. at the top. This is of radial brick, constructed by the Alphons Custodis Chimney Construction Company. Fig. 3 shows the Power House and chimney, from which an idea can be formed of the finished appearance of the various buildings. The construction is fireproof throughout, consisting of structural steel skeleton with fireproofed columns, beams and girders, brick curtain walls, metal sash glazed with wired glass, and steel and tile roofs.

The foundations of the larger buildings are laid on groups of piles driven by the Raymond Concrete Pile Company, the design calling for from three to twenty piles in each pier. About four thousand piles averaging some sixteen feet, in length were driven. Fig. 4 shows a view of the property at this part of the construction, and it will be noted that all excavation work for pier footings was carried on in caissons and the piles driven from the surface of the ground. The steel work throughout is of Bethlehem sections. It was fabricated and erected by the Dominion Bridge Company. Fig. 5 is a general view showing the steel work of Sections "B," "E" and "G" partially completed. This steel work is thoroughly fireproofed throughout by structural tile supplied by the National Fireproofing Company. The columns are covered with a 4-in. thickness formed of two 2-in. layers carried on top of sheet metal casings filled with concrete, some five and a half feet above the floor. The floor construction consists of a 6-in. segmental tile arch, this being the first example of such construction used in Canada. Figs. 6 and 7 show a typical section of this arch and the way in which beams and girders are fireproofed and floor sleepers embedded in concrete spandrel filling. On top of this is an underflooring of one-inch Canadian white pine and a top floor of clear maple.

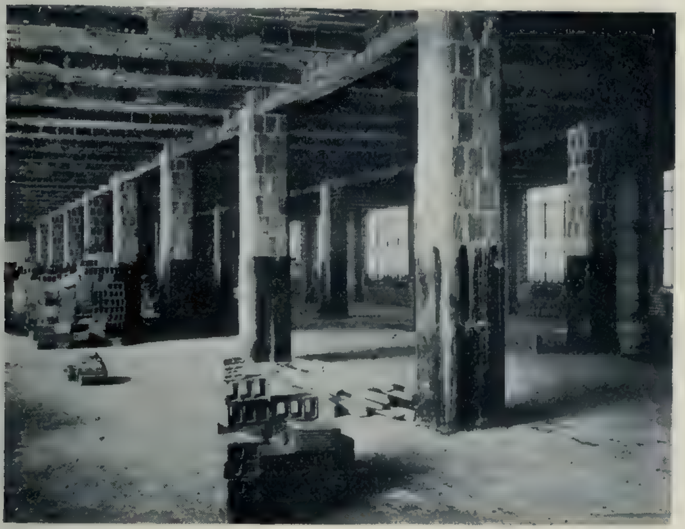


Fig. 7.—Illustrating method of fireproofing beams and girders and embedding floor sleepers in concrete spandrel filling.

Considered as a whole the buildings form an excellent sample of modern industrial building design, embodying the important principles of compactness, full measure of light, adequate working space, fire-proof efficiency, and the use of first-class workmanship and materials throughout.

About 50,000 cu. yds. of material has been excavated, about half of this quantity being used for backfilling and grading. Over 14,000 cu. yds. of concrete have been used in foundations exclusive of piles. The quantity of brick required for the whole job will approximate 6,000,000. Over 9,000 tons of structural tile has been used in fireproofing floors and roofing. Approximately 100,000 sq. ft. of glass is required for glazing the metal sash, exclusive of glass required for skylight work.

The work has been carried on under the direct supervision of Mr. E. F. Sise, President of the Northern Electric Company; Mr. J. D. Hathaway, General Superintendent; and Mr. W. J. Carmichael, Architect. The general contract has been carried out by Messrs. E. G. M. Cape & Company, Limited.

Reinforced Concrete Water Tanks in India

Two reinforced-concrete waterworks tanks, each of them 66 feet in diameter and 20 feet deep, have been built at Gaya in India. The thickness of the reservoir walls varies from 1 ft. 8 in. at the bottom to 9 in. at the top. The reinforcement consists of ¾-in. diameter round bars spaced two inches apart at the bottom and 9 in. at the top. The concreting of the walls was started about the end of February, 1912, just at the beginning of the extremely hot weather. Gaya is one of the hottest places in Eastern India, and the maximum temperature on the hill where the reservoirs stand, surrounded by bare rocks which reflect the heat with great intensity, probably reaches nearly 160 deg. in the sun during the hottest weather. Moreover, a dry west wind usually blows strongly in the daytime from the end of March onward. Notwithstanding these difficult climatic conditions, the reservoirs were constructed successfully. The inside was after completion plastered with 1:1 cement plaster ¾ in. thick, and the outside with cement plaster made up of three sand to one cement ½ in. thick. After the reservoirs were filled some moisture appeared on the outer face but apparently from general porosity rather than from any well defined leak. Most of these porous places have since become closed and the reservoirs are now practically watertight. An interesting feature of the work was the method by which the concrete was transported after mixing to its place in the walls. A large number of female coolies were engaged who carried the mixed concrete in small buckets on their heads. A bamboo staircase was built inside the reservoir wide enough for a stream of coolies coming in one direction to pass the stream returning.

Driving piles below grade has been necessary in the reconstruction of the 1,000-ft. Matawan Creek double-track trestle on the New York & Long Branch Railroad in New Jersey. The pile foundations were driven between the old bents about 12½ ft. apart and 30 ft. high while traffic was maintained on one track. The piles were 45 to 70 ft. and part of them were driven by a locomotive crane equipped with swinging leads having a telescopic section allowing the No. 2 Union steam hammer to follow the pile down 30 ft. below track grade. Part of them were driven with an ordinary driver with a 30-ft. follower. The pile bents were cut off, sills laid on them, caps secured under the existing stringers and the ten trestle posts inserted separately in position between them because clearance was not available for framing the trestle bents before erection. The work involved about 1,100 piles and 750,000 ft. of long yellow-pine trestle timber.

A report on the clay and shale deposits of New Brunswick, covering work done in that province during 1911-12 by Mr. Joseph Keele, has just been issued.

The Artistic Possibilities of Bonds and Mortars in Brickwork*

Registered in accordance with the Copyright Act.

Part II.—(Conclusion)

ONE of the most essential elements in brickwork is the mortar in which the bricks are laid. Upon examination of the definition of bond given above, we can see how it might be possible under the most favorable conditions to erect a wall without the use of mortar. In fact, the Greeks in their masonry construction did so erect their marble walls by rubbing the blocks together, after applying sand and water to the joint, until the desired planes were obtained. Thus laid the large blocks of marble, which were of sufficient size and stability to retain their positions in the wall by gravity, made a perfect wall. With our small clay unit of brick, however, there is not sufficient weight to a unit to permit the Greek procedure. Hence mortar is used, and it fulfils the double function of providing for each individual brick a bed in which the irregularities of surface are overcome and, what is still more important, of surrounding each brick with a bonding material which eventually produces a monolithic structure.

Mortar discharges two functions—the one structural, having to do with the nature and composition of the mortar as a bonding material; the other ornamental, affecting the appearance of the joint on the face of the wall, produced by its form, color, and texture.

Structural Uses of Mortar

Viewing the matter from a structural standpoint, it is of fundamental importance to use a thoroughly sound, well tempered, and well mixed mortar, neither too stiff nor too plastic. The proportions of the ingredients should be kept strictly uniform throughout any given job. The building ordinances of every large city dictate the legal composition of mortar to be used in that city.

Generally speaking, mortar is composed of cement and sand, or lime and sand, or cement mortar and lime mortar, mixed in various proportions. But to secure certain desired results, the sand may be partly or entirely replaced by other materials. Thus for a wide joint fine gravel—not over one-fourth inch in diameter—ground granite, or crushed birck is used wholly or in part for the sand. For a white joint, coarsely ground white marble or limestone may be substituted; or for fine joints, which are meant to be very white, pulverized white marble is frequently used.

In any case the material must be of the very best. The cement should pass the proper and usual tests as set forth by the American Society for Testing Materials; the lime should always be fresh and well burned, and of a character which will slake into a smooth and even consistency, without lumps of hard or underburned material: and the sand should be free from loam, pieces of charcoal, iron oxide, or other material of like character.

A great many architects will not permit the use of anything but a purely cement mortar. A number of city ordinances also require that the mortar used shall not be inferior to a mortar composed of one part of Portland cement and three parts of clean sand, thoroughly mixed dry, so as to be of one uniform color, with the proper amount of water added to make a smooth working composition; and shall be used while fresh. Some engineering authorities, however, will permit of as large a proportion as four of sand to one of cement.

The usual practice is a mixture of lime mortar and cement mortar. A specification for this mortar would be as follows—or in similar proportions: "The lime mortar shall be composed of five bushels of fresh burned lime to one cubic yard of sharp river sand; this mortar to be made up so as to have two weeks' supply ahead of the work—no lime mortar that is not at least two weeks old to be ued. The cement mortar is to be composed of one part of approved Portland cement (showing a tensile strength of 500 pounds per square inch on seven days' exposure) and three parts of clean sand; the cement mortar to be mixed fresh each day just before being used and in such quantities that none shall be left over at the end of the day's work. Take of the above mortars equal parts, thoroughly mix and use fresh, not allowing the mortar to set before using in the walls," Thus mixed, these mortars when set become a pale gray color, of either a greenish or bluish tint, depending upon the brand of cement used. The effect of lime mortar in the mixture is to produce a much lighter color in the finished joint than is obtained by the use of a pure cement mortar.

Artistic Effects

But being primarily interested in the artistic aspects of brickwork, it is fitting that the form, texture, and color of the joint as it appears on the face of the wall should here be emphasized. The form and color of the mortar joint become an added factor in the development of artistic brickwork and should be used with understanding and skill, since as usually estimated, the surface of the mortar ranges from one-seventh to one-fourth of the whole surface of the completed wall. The entire color scheme of the wall may be changed either by the manner of treating the mortar joint or by the introduction of color into the mortar. Thus the flush joint, that is, the cutting of the mortar flush with the face of the brick, results in a decided line of color, which may be large or small according to the size or width of the joint. Or, to take another example, with the sunk or cut joint, which practically eliminates the color of the mortar altogether, we get a shadow line around each brick.

The study of color in the mortar joint will often enable the designer to bring his entire wall surface into the harmony of color he is striving for. On the other hand, piers and openings may be featured, and architraves and quoins may be produced around an opening or at the angles of the building, by the simple expedient of using a flush joint at these places and a sunk joint on the intermediate surfaces, or the reverse.

Bond pattern in brickwork may be entirely lost by the use of a mortar joint ill-chosen in form or size; while beautiful texture and beautiful pattern may be accentuated through the mere treatment of the joint alone. Or pattern may be brought out in a brick wall of uniform color by the way in which the border joints, enclosing the pattern units, are handled.

---

*By the kind co-operation of The Hydraulic-Press Brick Company, St. Louis, Mo.

Texture in the joint, that is, the surface of the mortar as it appears to the eye, should harmonize with the texture of the brick. Thus a rough-textured brick is shown to the best advantage by a rough joint. A rough joint however, it must be observed, does not mean an unworkmanlike joint. All joints, rough or smooth, should be workmanlike in that they meet the edges of the brick in a clean, sharp manner.

A rough or granulated surface in the joint is obtained by the use of very coarse sand or fine gravel, the face of the joint being either cut with the trowel or scraped with a jointing stick so as to roughen the surface of the mortar. A smooth joint is obtained by the use of a steel jointing tool, or by pressure applied to the toe of the pointing trowel. Large joints should usually be rough surface joints, and, as already indicated, are used to best advantage with rough-textured brick, although beautiful effects may be obtained by using this joint with a smoother or fine-textured brick. Some of the most famous brick designs in this country, however, are of the opinion that all rough-textured brick should have a raked joint, that is, a joint cut back from the face of the brick, often very deeply, "leaving the brick surface thus free to expose its color and texture, and the individual brick to play its part and place as a unit therein."

Kinds of Mortar Joints

The usual mortar joints in good brickwork are indicated in the accompanying cross-section sketches and photographic reproductions. Joints A and B are trowel-struck joints, and are usually made by the bricklayer as the work progresses, being the common jointing in ordinary brickwork. As American mechanics usually work from the inside of the wall, joint A is the easier joint to strike, while joint B, the so-called weathered joint, requires more care, as the trowel has to be worked from below. But this form of joint is the better able to shed the water and is the more permanent joint of the two.

Joint C is a raked joint, made by removing the surface of the mortar, while it is still soft, with a convenient tool. Joint D shows a set-back, or stripped, joint which is made by laying wooden strips on the top of each course and filling up with mortar behind these strips, bedding the brick on the top of the strip which is removed when the mortar is sufficiently hard to sustain the weight of the brick. While the joint stripping adds considerably to the expense, it accomplishes the result of having the bottom edge of the brick on a level line, prevents the smearing of the face with mortar during the course of erection, and generally tends to equalize the hoizontal joint. Both the raked and the set-back joint have a tendency to darken the appearance of the wall, owing to the deep shadow which the joint makes on the surface. These joints are very effective and bring out with great distinctness any pattern with which they may be used.

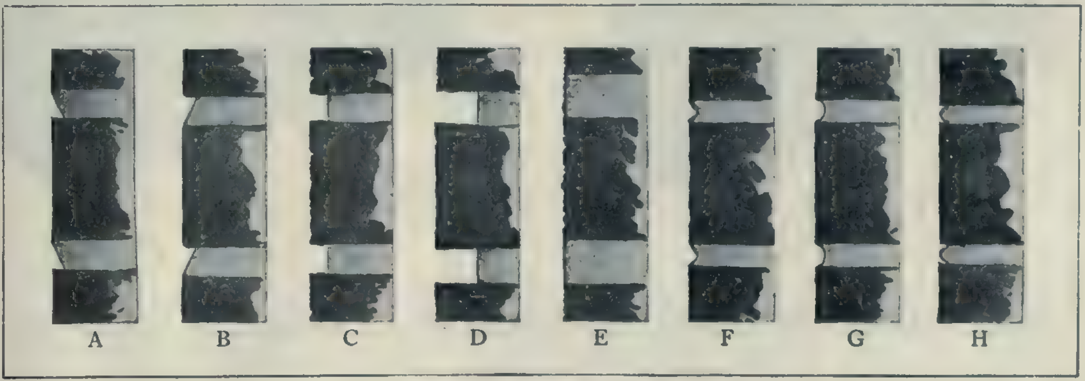
Joint E is a rough-cut flush joint, which is made by cutting off with the trowel the surface mortar projecting beyond the face of the brick. The exposed surface of the mortar must be left just as it is after the excess mortar is cut off, as any repointing or patching of the joint is not only very apparent and breaks the color effect of the surface of the joint, but also is likely to be injured by the action of the elements.

Joints F, G, and H practically belong to the group of pressed brick and smooth surfaces, and are joints that are normally kept quite small. They are better suited to interior work and are formed by the use of a steel jointer which, in order to make the lines true, is drawn along a straight edge.

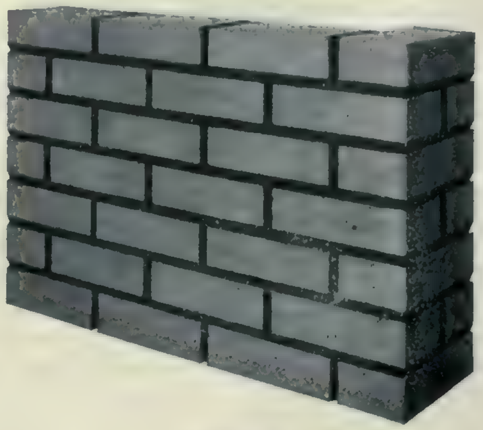
Terrace floors and steps, when built of brick, are usually pointed with what is called a "thumb" joint, which is a broad slightly concave joint thoroughly rubbed down with a steel jointing tool. It is good practice to have the exposed face of brick used for terrace floors and steps given a good coat of raw linseed oil immediately before laying, as this practice prevents the mortar from sticking to the face of the brick and permits of clean, clear, finished work.

The addition of color to mortar is one of the expedients that is at the command of the designer of artistic brickwork, to produce that nice degree of harmony of the total wall surface so frequently necessary for securing the essential character of his design. Colored mortar is needed to bring out the life and character of certain tones of brick and is in itself a serious study. The color required to harmonize with certain brick tones can only be found by experiment, and that experiment should always consist of laying a section of sample wall in the colored mortar joint as proposed, large enough to permit a judgment on the finished whole.

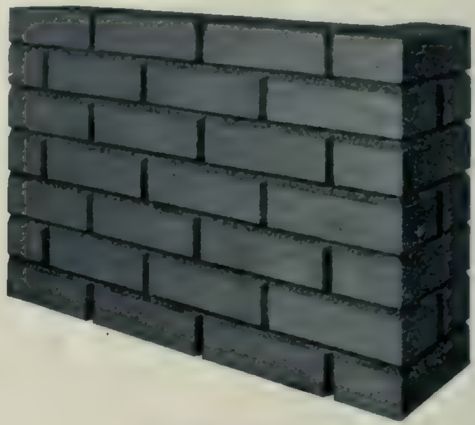
There are many fine artistic effects that may be secured by the use of artificially colored mortar which harmonizes with color tones and textures in the brick. Two walls laid of absolutely the same kind of brick will present an altogether different appearance if laid



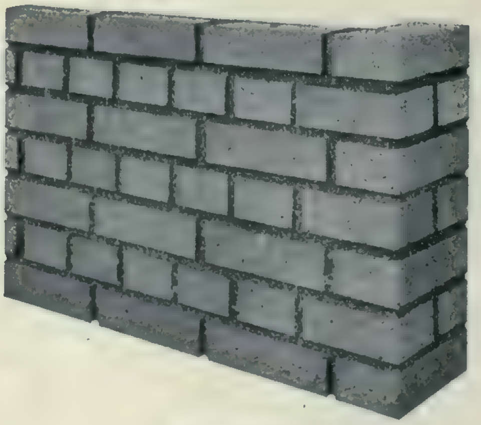
Bonds and Mortars in Brickwork.



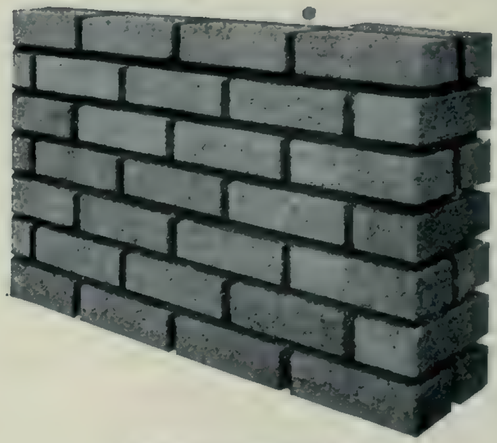
Struck Joint



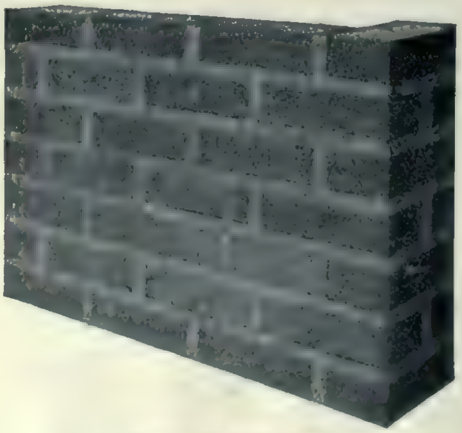
Weathered Joint



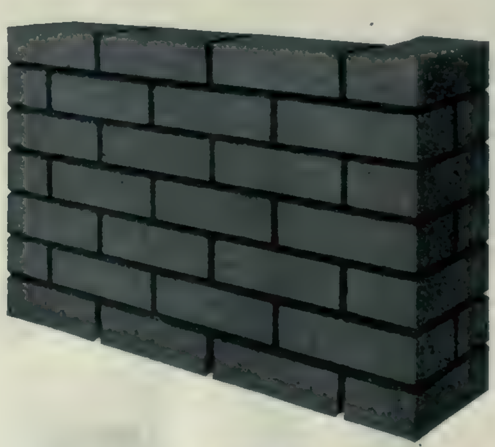
Raked Joint



Set-Back, or Stripped, Joint

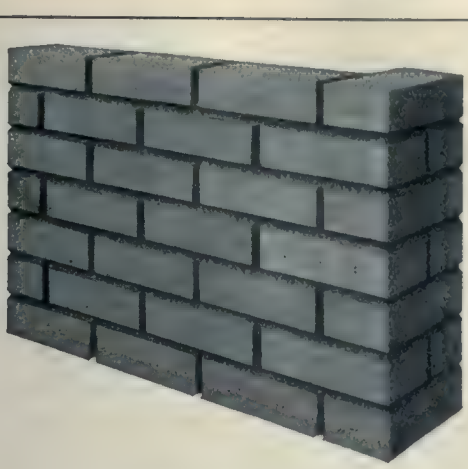


Rough-Cut Flush Joint

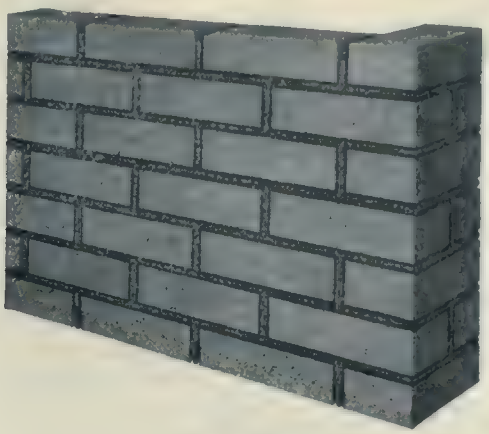


V-Shaped Joint

The Artistic Possibilities of Bonds and Mortars in Brickwork



Round, or Rodded, Joint



Beaded Joint

Bonds and Mortars in Brickwork

in different colored mortars, an effect that is enhanced if, in addition, there are used different forms of joint. In one wall use a rough-cut flush joint of dark mortar, and in the other a light mortar raked out deep, and the observer could hardly be persuaded that the same brick had been used in both walls. But mortar colors, the reader must be advised, are materials rather difficult to deal with, and the greatest care must be taken in their selection, not only to secure just the shade wanted but to avoid using those that are chemically affected by the lime or cement of the mortar. An otherwise beautiful wall may be almost ruined by a false tone of color (artificial or natural) in the joint, while, on the other hand, its beauty may be greatly refined and enhanced by the employment of a harmonious color in the mortar.

There are two methods by which colored mortar may be used. The first is its use as the actual working mortar in which the wall is laid. The second is its use in tuck-pointing the wall at the completion of the job. In rough-textured joints the first method is practically necessary. Where a steel jointer may be used, tuck-pointing becomes much the best method of producing the desired result. Fortunately for the designer, it is seldom necessary to produce vivid or strong color in a rough-textured joint.

The ideal practice would be first to complete the entire wall with an inch-deep raked joint, and then, after cleaning down the work, to tuck-point it in fair weather from one batch of the properly colored mortar, at one time, and in one operation. Some colors more than others, especially blacks, seem to require this care, for the daily stoppages of the work and other delays show in the bleaching of the last few joints on the top of the unfinished wall, caused by the action of the sun and the elements. But as, in view of the added expense, this is rarely done, the next best expedient is to cover the last few courses at the end of each day's work, and to secure an experienced and conscientious mixer who has the ability and inclination to use exact proportions in reproducing from day to day the uniform batches of colored mortar necessary to complete the work.

The two-and-a-half-million-dollar plant now in course of erection at Dauntless, Alta., for the Canada Cement Company, is being equipped with five kilns, each 24 ft. in length and 10 ft. in diameter, each of the 85-ft. sections weighing 720 tons, including fire brick lining and an average load of material. These are said to be the largest cement kilns in Canada and the second largest in the world. A ten-ton gear is equired to drive each kiln and bearings weighing 15 tons support the weight. The raw material passes into the kilns in a semi-fluid state, the moisture being driven off by hot gases at a temperature of 2,500 deg. Fahr. The cost, including installation, will be $75,000 for each kiln. The plant at Dauntless when completed will have a daily capacity of 4,000 barrels.

A new industry has been started at Lethbridge, Alta., under the title of the Lethbridge Face Brick & Clay Products Company. Mr. Jas. M. Close, of Woodstock, Ont., who is the inventor of several important machines used in brick manufacture, has arrived in Lethbridge and will devote his whole time to the management of the new business. The company, which includes Mr. William Close and Mr. Charles Cherrett, also of Woodstock, intends manufacturing tapestry brick, dry pressed brick, hollow brick and drain tiles, and it is anticipated that the first products will be on the market early in July. A site of sixteen acres has been purchased from the C. P. R. for the accommodation of the plant.

Brick and asphalt block pavements at Savannah, Ga., are laid on a carefully prepared natural earth foundation. According to Mr. E. R. Conant, Chief Engineer of the city of Savannah, this soil is, with few exceptions, well drained sand mixed with loam or clay, and, when thoroughly rolled or tamped, gives such good results as a foundation as not to warrant the use of a concrete base where the traffic is light or medium. The pavement subgrade is shaped roughly, finished with a steel-lined wood-drag and tempered with water. The brick or asphalt blocks are laid directly on the subgrade, and the points are filled with sand. Brick have been laid on edge heretofore, but laying flatwise is under consideration. Unevenness in brick pavements in Savannah, Mr. Conant states, is due not to a yielding of the foundation, but to the wear of the brick. Last year some of the old brick pavements were taken up and turned and relaid, and about 10 per cent. of the total replaced with new brick, all at a cost of about 30c per square yard. The average cost of brick pavements for ten years past at Savannah, laid as above, has been $1.55 per square yard.

A Discussion of Coal-Tar and Asphalt Products for Waterproofing*

By **S. T. Wagner**

THE increasing number of solid-floor bridges, especially in cities, involving waterproofing and the expenditure of large sums of money, and the necessity of thoroughly protecting steel reinforcement in concrete under certain conditions, as well as the waterproofing of masonry in general, make the study of the various external methods of waterproofing of the greatest importance. The methods referred to consist in the application to the surface to be waterproofed of either a membrane of felt or fabric of some kind thoroughly cemented together with some bituminous material, or a layer of inorganic material impregnated with the same substance. There can be no question but that the bituminous material so used is the real waterproofing medium, and that all other materials incorporated therein are simply fillers to retail the bituminous material in place and give it additional reinforcement of some kind. Whether the waterproofing is applied for the protection of the public from drippings from an overhead railway bridge, or is used to prevent the corrosion of reinforcing material in concrete construction exposed to water, the object in either case is to obtain a layer of durable waterproofing material which is suitable to each particular case. Waterproofing is expensive, it is always very difficult and costly to repair if defective, and it behoves the engineer to use the best materials that he can secure and to apply them with the greatest care to the structure, which should be especially designed to meet the necessary details required in good waterproofing practice. There is much uncertainty at the present time as to a number of points in connection with this character of work, but there appears to be almost complete agreement that the perfect or imperfect application of the materials determines a good or bad piece of work. It would appear that, outside of particular instances where waterproofing is used to keep water in, the majority of cases are those in which the object is to keep the water out, and of these a very considerable portion of the structures requiring its use are essentially different, as indicated above—first, solid-floor bridges; second, underground masonry. In the first case the conditions are such as to require special elasticity at all temperatures, in order that the waterproofing may adjust itself to the vibrations of the structure, especially in the cases of railroad bridges of relatively short span. It is usual to have a regularly ballasted floor, which, if properly drained, makes a condition for which we can say in general that the oxidising action of the air is probably a more potent factor in the disintegration of the waterproofing material than the action of whatever water may be present. In the second case, we may safely say that when the masonry is covered with even a small amount of earth, the action of the air is negligible and that of the dampness, or water, is the more serious. In some instances water may be in constant contact with the waterproofing. The materials to be used should, therefore, have chemical and physical characteristics which make them suitable for the above-mentioned conditions.

There are in use at the present time two general classes of materials for waterproofing purposes when the conditions are as just described: First, compounds of an asphaltic nature; second, coal tar pitch. Both of these materials have been, and are at present, used quite extensively and with varying success. The successes or failures in many cases have been due to proper or improper application as much as to the inherent qualities of the materials themselves, and it is believed that the successful use of either class has often been attributed to this fact rather than to the real qualities of the materials, and that at the present time the amount of reliable data as to what is needed in the way of a specification for the proper material to be used is woefully lacking. To one who is not a modern chemist and thoroughly versed in the mystic symbols of the hydro-carbons, the chemistry of these materials is almost hopeless in its practical application; but it is quite evident that there is an essential difference between them chemically—that is, between such figures as are usually given in chemical analyses. The physical properties are apparently much more interesting and useful to the practical engineer, and it would seem that we could do away with the chemical data unless they indicate properties which, when translated, will enable us to distinguish undesirable, or it may be, dangerous, elements. We can understand and appreciate such figures as melting point, brittle point, elasticity at various temperatures, and consistency, and data concerning these properties give us a very fair idea of the various physical properties.

The data which seem to be needed are those from laboratory tests which will enable as to determine the relative durability of these products—first, when exposed to the air; second, when exposed to water; and third, when alternately wet and dry. Any such test is, or would be, essentially an accelerated test. It is possible that at the present time the question of durability might have to be answered by practical experience with the different materials in existing structures. However, it does seem that some information as to what we should aim at and what should be avoided is due from the manufacturer or the chemist. Nothing inspires the confidence of the user of a structural material so much as the free discussion of the methods of manufacture on the part of the manufacturers. Experience in the past with other materials has shown that this confidence is not abused in the preparation of specifications. Such information is badly needed in connection with waterproofing materials. From recent investigations and research there seems to be a general impression that when exposed to the air, asphalt products are more durable than coal tar products, and that the opposite is true when exposed to water. The opinion that asphalt products are more suitable for use on solid-floor bridges seems to be of general, though not universal, prevalence, on account of the greater elasticity of this material at low temperatures. In other words, an asphalt product with a melting point of 150 deg. Fahr., which will be ductile at a temperature of 40 deg. Fahr., or lower, can be obtained, while a coal-tar pitch with the same properties can not. It has been the experience of the writer that asphalt mastics made with natural rock asphalts, when fluxed with asphalt compounds of high ductility at low temperatures, produces mastics which are much less liable to crack in service than are those in which the flux used is brittle when cold. Water to a certain extent is a solvent of all asphalts, but from the tests of Whipple and Jackson it is quite evident that the question of solubility is a comparative one, and the tests there given show that there are classes of asphalts upon which the action of water is very slight. In this paper a quotation is made from Richardson which shows that the action of water upon coal-tar is about two-thirds of that upon Bermudez asphalt cement when expressed as the gain in weight in water in a given time. Bermudez asphalt in the tests made by Whipple and Jackson is among those which were most affected by water. A number of cases of the durability of coal-tar pitch in actual service in underground work seem to indicate very positively its suitability for this class of work. Will someone say whether or not properly-selected asphalts are unsuitable under similar conditions? Apparently the questions which need to be answered are the following:—

---

* Paper presented at a meeting of the American Society for Testing Materials.

1. What kind of materials are most suitable for general application to (a) solid-floor bridges; (b) underground masonry?

2. If asphalt products are used, what should be specified?

3. If coal-tar products are used, what should be specified?

Fire-Resistant Construction and Equipment of Buildings*

THE use of the term "fireproof" is recommended to be discontinued. This general term has been erroneously applied to buildings and materials of a more or less fire-resistant or incombustible nature. Its indiscriminate use has produced much misunderstanding and has often engendered a feeling of security entirely unwarranted.

The term "fire resistant" shall be applied to all structures or materials which will satisfactorily resist the effects of a serious fire. The committee submits the following standard tests, which discriminate between fire-resistant materials and systems of construction affording "full," "partial" and "temporary" protection against fire: 1, full protection implies resistance to a severe fire for four hours; 2, partial protection implies resistance for two hours; 3, temporary protection implies a resistance to a severe fire for at least one hour.

Furniture and Fixtures

Some thirty-five years ago, when fire-resistant buildings of the steel-beam type were first erected, fear was expressed by some officials of the insurance companies of those days, that insurance against fire would soon be unnecessary. This feeling of security is still indulged in by many well meaning people who take it for granted that their lives and goods are safe, if within what was then called a "fire-proof" building, and what we now have more properly designated a "fire-resistant" building. In spite of some lamentable disasters, the popular imagination still is that the contents of a fire-resistant building will not burn, so that when flames are seen issuing from the windows of a building known as "fireproof" there are some people who will refer with derision to the "fireproof" building, and even some journals will print "fireproof but it burns."

This feeling that all depends upon the building has been reflected by those who are intrusted with the making of building laws, for though they endeavor to make building construction more and more fire resistant, they devote little or no attention to the contents. Many lives and much property have been lost due to the inflammable nature of the building's contents, and there are many instances where this loss has occurred but where little or no damage has happened to the building itself, though of the most ordinary nonfire-resistant type.

Much time and thought have been given to the planning and construction of buildings to render them fire resistant, and with good results. But with comparatively little expense greater results may be obtained by providing fire-resistant furnishings and equipments to protect the lives of the occupants and the contents of the building. There are already many buildings equipped in accordance with the standard proposed.

Recommendations

1. All solid partitions to be of metal lath and cement plaster, terra cotta, brick, magnesia, or other incombustible material. All doors with trim shall be of metal covered or other non-inflammable material, and no wood shall be used except metal-covered.

2. All glazing of sash partitions, including doors, shall be of ¼-in. wired glass in metal frames, with the balance of the construction of metal, or metal and plaster, or other incombustible material, and no wood unless covered with metal shall be used.

3. Wooden-slat partitions or slat guards back of fire-doors or elsewhere shall not be used; wire screens set in metal frames or other metal guards are suggested.

4. All shelving shall be of metal or other suitable incombustible material. Where the contents of the shelving is of an inflammable nature, the fronts of all shelving to be provided with doors of same material as shelves. If required to be glazed, the same must be done with wired glass fastened with metal independent of putty.

5. All clothes lockers or closets shall be of metal, and not more than ten in one space or area, unless kept in a separate room inclosed with fire-resistant material. No wood shall be allowed except in tops where the under side must be protected with metal.

7. All stockrooms or storage rooms containing in-

---

* Abstract of the report of the Committee on Fire-Resistant Construction, presented at the annual meeting of the National Fire Protection Association, at Chicago, May 5-7.

flammable goods must be inclosed to the ceiling with fire-resistant material; no wooden-slat partitions shall be used.

Construction Plant and Methods Employed in Re-Concreting the Lining of a Reservoir

THE work of relining with concrete the west basin of the Eden Park reservoir of the Cincinnati waterworks, which is now nearing completion, is described in a recent issue of our Chicago contemporary, Engineering and Contracting, by Kenneth C. Crain. The article presents several interesting constructional features. Mr. Crain explains that the work was undertaken last July under a 152-day limit, with a subsequent extension of 47 days, but this time, as is evident, proved inadequate.

The principal cause of the delay was the difficulty experienced in removing the old concrete, which was laid in 1876, and which averaged 18 ins. in thickness. In some parts it could be handled with pick and shovel, but for the most part its removal required the use of dynamite, and this while effective, was somewhat slow. The method used was, starting from the top, to drill holes under the concrete at varying distances apart, and as deep, or long, as 6 ft. The charges varied from half a stick to a stick to each hole.

The old concrete was left in the bottom of the basin, after a thorough testing to develop any possible weak spots. This was done by using a 14-ton roller, which traversed every portion of the basin without causing any yielding. It was assumed that this test gave an ample factor of safety for the greatest possible load of water, the maximum depth of water under service conditions being 40 ft.

The object of relining the basin was to prevent seepage of the water contained in the reservoir which, it is stated by the city authorities, sometimes amounted to as much as 2,000,000 gals. a day from the two basins. The capacity of the west basin, on which the work is now going on, is 50,736,000 gals., and that of the east basin, which is to be similarly treated, is 44,097,000 gals., indicating a daily loss by seepage of nearly 2 per cent. of the total capacity.

The new lining, therefore, is designed to be as nearly waterproof and watertight as it is possible to make it. For this purpose, therefore, it is constructed under the following specifications, in brief: Graded, as far as necessary to secure a smooth surface on the slopes, and a course of 6 in. of crushed rock, from 1 to 3 ins. in greatest dimension, applied and tamped solid. Upon this is laid a preparation of heavy felt, impregnated with asphaltum, and about ¼-in. thick, made by the Barber Asphalt Company. This waterproofing comes in strips 15 ft. long and 4 ft. wide, and is laid with 6-in. laps, connected together with pitch.

Upon this is placed a 6-in. slab of concrete, in 15-ft. squares, a 1-2-4 dry mix being used, the aggregate being crushed rock and old concrete, taken from the reservoir itself, 1 in. in greatest dimension and smaller. This new lining, it is believed, will make the basin absolutely watertight, thus preventing any further seepage of consequence. In order to take care of such surface waters as may find their way down under the felt, from the sides, however, 10-in. tile drains are provided. The lines of tile are placed under the bottom course of crushed rock, and led to a sewer outlet in the center of the basin.

The placing of the concrete on the slope sprobably basin has been a simple matter. After the crushed rock layer is rolled and the felt placed upon it and allowed to become fixed, the mixture is wheeled to place in two-wheeled steel hand-carts. Fifteen-foot steel plates, ¼ in. thick and about 7 ins. wide, wired together, are used as forms. The thickness of these forms provide space between each square, after their removal, for a pitched joint. A separate ¼-cu. yd. mixer takes care of this part of the work. It is operated by a 10 h.p. motor.

The 85-ft. slopes, however, have presented greater difficulties in every phase of the work. The necessary re-grading, after the removal of the old concrete with dynamite, could not be done with a roller or any other of the usual equipment, on account of the steep pitch, running as high as 45 deg. in many places; and this, therefore, was necessarily pick-and-shovel work. Likewise, the work of settling the crushed-rock bottom course had to be done by hand-tamping.

The placing of the concrete on the slopes, probably presented the most difficult problem of the entire job, not as being of a complicated nature, but as offering obstacles to speed. The concreting plant finally evolved by the company consisted of a single traveller, bearing all of the washing, handling, conveying, crushing and mixing equipment.

The crusher on this traveller was used only as long as the old material held out, crushed rock being hauled to the job since that time. A clam-shell bucket, operated from a boom by an engine on the traveller, lifts sand and crushed rock from the piles alongside the traveller to an upper level, from which they are chuted to the mixer as required. A ½-cu. yd. mixer is operated on this part of the equipment, dumping into a bucket which is lifted to the proper point on the slope by a boom working on a frame extended from the traveller.

The concrete, poured from this bucket is placed to the desired thickness by men with hand-tools, and, being a stiff mix, has given little trouble from sliding after placing. At the bottom of the slopes, however, when the concrete is laid on the slope before the bottom concrete has been placed, heavy timbers are used to prevent any movement of the material.

The work required 6,220 cu. yds. of concrete, and about an equal amount of crushed rock for the bottom course. The contract price of the work was about $102,000. The work will probably be completed in a short time. The arrangements for similar work on the east basin have not been made, but this contract will probably be let shortly after water is turned into the section of the reservoir on which work is now going on.

Nelson, B.C., is spoken of as the probable centre of the location of a zinc plant. Mr. W. McA. Johnson, of Hartford, Conn., inventor of an electric process for the smelting of complex zinc ores, visited Nelson recently accompanied by Dr. Struthers, a prominent New York mining man, and Dr. Barlow, formerly of the Dominion Geological Survey, and now lecturer in the Mining Department of McGill University. The feasibility of establishing the plant at Nelson was discussed with the local Board of Trade.

The Des Moines River viaduct of the Chicago, Milwaukee & St. Paul Railway, three miles west of Madrid, Iowa, is 2,394 feet long and 130 feet in maximum height. It consists of 40-ft. tower spans, 70-ft. intermediate spans, and two 155-ft. truss spans across the river. Most of the concrete pedestals are supported on piles. The layout work was done by means of repeated horizontal measurements with a 100-ft. steel tunnel tape. A spring balance was used and the tape was supported every 33 feet. Corrections were made for temperature. At each measurement point an 8-in. oak post 5 ft. long was set in the ground and a zinc plate tacked on top. This enabled the establishment of an accurate and permanent point. Independent lines were run, establishing the 100-ft. stations, and the bents were checked from these points. At the end, close measurements were also taken as a check. Much of the measuring was done at night in order to secure the benefit of a more even temperature. The layout provided for a normal temperature of 70 deg. Concrete benchmarks extending 5 ft. into the ground were placed so that direct readings could be made from benchmark to every pedestal, and these were checked independently by three sets of levels, run at different times by different men, there being no greater variation than 0.008 in. between the different elevations at any bench mark.

The First Canadian and International Road Congress at Montreal

(Staff Report)

THE promoters of the First Canadian and International Roads Congress, held in Montreal from May 18 to 23, may be congratulated upon the large attendance of delegates from all parts of Canada and the United States. The Congress had the support of the Federal and Provincial Governments, the City of Montreal, and many public bodies. The papers read were excellent, and if the delegates did not add to their stock of knowledge it was not for the lack of pointers which were offered. Many of the men who took part in the proceedings are recognized as the highest authorities on different branches of highway engineering, and their papers nearly all insisted on the urgency of expert advice being sought if the expenditure on roads is to result in permanency and economy.

The Arena, where the conference was held, was artistically decorated, and the auditorium (where the papers were read) was one mass of British, American, and French bunting.

The Opening

The opening ceremony was a very successful function. The speeches were all to the point, and emphasized the growing importance of the good roads movement. Welcome to the delegates were given by Sir Francois Langelier, Lieut.-Governor of Quebec; Sir Lomer Gouin, Premier of the province; Bishop Farthing, and others.

Mr. U. H. Dandurand, the president, occupied the chair.

In opening the Congress, Sir Francois Langelier spoke of the importance of good roads to the farmer and to the city man. He pointed out that it was only a comparatively short time since people began to turn their attention to this subject; formerly the people in the country districts neglected their roads, and refused to appoint competent engineers. The coming of the motor car had caused a revolution in road-making, and although there had been a prejudice for fear that the city people wealthy enough to own automobiles would get most of the advantage they were beginning to see that the roads would be of inestimable advantage to themselves. Those bad roads were one of the most potent causes in driving people from the country to the city. Sir Francois praised the Gouin Government roads policy in lending money to municipalities who were to pay two per cent. interest on it, and the Government the principal and the rest of the interest.

Sir Lomer Gouin declared that the province was ambitious to have roads which were second to none in the Dominion, and expressed the opinion that Quebec had shown more progress than any other province. In order to carry out the work they had created a special department. Turnpike trusts were sometimes criticised but they were a necessity of their time. The Government had spent a large sum of money on roads, but much more remained to be done.

Hon. Louis Coderre brought a message of encouragement from Mr. Borden. They had every hope that differences between the Federal and Provincial governments would be smoothed out.

Hon. J. A. Tessier, Minister of Roads in the Gouin Cabinet, the Hon. Honore Mercier, and Ald. Leslie Boyd, for the City Council, welcomed the delegates.

The Conference

Only two papers were read on the opening day—one by Mr. W. A. McLean, Commissioner of Public Works of Ontario, who dealt with "Highway Legislation." He spoke of the neglect of roads in former times, and said that in looking into highway legislation it was not possible to superimpose upon any country the code that belonged to some other country. They had to study the peculiar conditions of each country, and accept the code of any country in so far as it would apply to their own circumstances. Mr. McLean then referred in detail to the system of highway legislation in Ontario, by which the expenditure was divided, and went on to say that the road work should be in charge of permanent men. The city should help pay for public highways, municipal self-administration should be encouraged, and the central administration should come in at certain points to help.

Mr. A. N. Johnson, Chief State Highway Engineer, Springfield, Illinois, took as his subject "Planning a System of Public Roads." His chief contention was that the very first necessity in road construction was to make a plan of the work that is to be done over a wide area, so that in the future years whatever work was done, they would be working on a recognized system which, when completed, would be twice as valuable from its very unity. He stated that people must be prepared to spend more money, as changed conditions required a more durable form of construction. Mr. Johnson also discussed brick and concrete roads and their relation to the class of traffic which had to be provided for.

Five papers were read on Tuesday, May 19th. After an opening address by Mr. U. H. Dandurand, Mr. W. A. McLean, presided. The first paper was on "Important Considerations entering into the Selection of Pavements for Roads and Streets," by Mr. W. H. Connell, chief of bureau department of public works, Philadelphia. It was admitted, he said, that highway engineering had not kept abreast of the time as compared with the standard set in other branches of engineering work. As a matter of fact the problem that presented itself through the advent of the automobile, which had resulted in revolutionizing traffic conditions, was only just beginning to be solved, and it was equally true that it had never received the attention it deserved, and was generally looked upon lightly by both the engineering profession and public officials. The highway departments afforded a splendid opportunity to parcel out jobs to men from all walks of life and without any qualifications for the work. Highway work as an engineering problem was still in its infancy, and public officials and the public generally had yet to be educated to the point where they would appreciate that this branch of engineering work required special study, and that haphazard statements which were not based on experience or a knowledge of the subject were just as unwarranted as they would be in connection with any other scientific subject or business enterprise. Enormous sums were being wasted, and agitations and investigations going on in different highway departments, which would make it appear to the general public that engineers were not solving the problem. To a certain extent this was true, but not because the men who had made a special study of this branch of engineering had not the ability to build good roads and pavements, but because it was not under their control. This state of affairs, which usually had its origin in highway departments being run by officials who had not any experience or training to qualify them for the particular work, was the side of the subject which was more generally before the public. It was only through meetings of this kind that the public would come to appreciate the necessity of placing the highway engineering problem in the hands of men of experience and qualifications for controlling work of this kind. In other words, highway engineering must be put on the same plane as all other lines of business and professions and branches of the engineering profession. Next in importance to the personnel they should in building a road give careful consideration to the drainage, the traffic and probable future traffic of the road, the foundation on which the road would be built, the gradient, the social, local and sanitary conditions and the wearing surface required.

Valuable Papers by Major Crosby and Mr. E. A. James

In a paper on "Points Worth Noting in Connection with Road Improvements," Major W. W. Crosby, consulting engineer, Baltimore, Maryland, stated that there was too often an apparent insufficient comprehension of the importance of organization of the administrative and executive forces under the laws governing the work. It had been too often the practice to attempt to expand the old organization by adding new units of the same character to it, so as to carry on the new work, when what should have been done was to recognize the different characteristics of the new work, and to reorganize the entire department so as to provide such a machine for the combined operations as would properly and efficiently produce the results desired. In discussing the question of the selection of the methods and materials to be used itself, Mr. Crosby declared it was useless to look for a permanent road if by the expression was meant a road that would not require yearly expense for its up-keep. It would only too frequently be found to be the case that mistakes from the point of view of expenses had been made by the vain attempt to secure regardless of cost a "permanent" road surface, and that a saving would have been made, had a cheaper surface been relaid and replaced as needed from time to time. This was especially true where traffic conditions were in a changing state. It was of the most importance that the sub-grade, on which macadam was to be spread and built, should be made firm and even before the macadam should be spread. The importance of this specification was often not realized by inexperienced engineers and contractors. The proper rolling of the macadam material was too often slighted.

Mr. E. A. James, consulting engineer, York County Highway Commission, Toronto, was unable to be present, but he sent a paper which was read by Mr. W. Hubert, who explained the great results obtained by Mr. James in that county, and the demonstration given by his experience that adequate maintenance was as much needed as good construction. Mr. James stated that nine-tenths of the objections to macadam roads arose from an improper observance of the rules which govern their maintenance, and not from difficulties of construction. He gave a list of the various agencies tending to destroy such roads, giving a special word of disapproval to the narrow-tired vehicle with its tendency to form ruts which in turn interfered with lateral drainage and so impaired the road. He described the characteristics of a good macadam road that would require least attention and expenditure to keep in shape, and favored the patrol system of maintenance, finding both the statute labor and the contract labor systems of upkeep unsatisfactory.

Other papers were "Good Roads as a Factor in the Progress of Cities and Towns," by Lt.-Col. W. N. Ponton, Hon. President, the Ontario Associated Boards of Trade, Belleville, and "L'Organisation Administrative des Routes de France," by R. Lehmann, engineer of the French Government Service, New York City.

On Tuesday evening the delegates dined at the Windsor Hotel, when speeches were made by Sir Francois Langelier, the Hon. Louis Coderre, Hon. J. A. Tessier, Mr. J. W. Levesque, M.L.A., I. S. Pennybaker, executive assistant American Highway Association, Mr. W. A. McLean, Controller McDonald, Mr. O. Hezzelwood, and Mr. A. G. Batchelder, chairman of the American Automobile Association. It was announced by Mr. Tessier, for the Quebec Government, that they intended to help the various counties secure a complete road outfit for the making and maintaining of good roads. He also announced that the Government would make a grant to the Congress.

Mr. L. S. Pennybaker, executive assistant, Washington, of the American Highway Association, presided at Wednesday's session.

Mr. C. L. Shorey, chairman of the Good Roads Committee, Beaconsfield, P.Q., spoke of the progress made in his town, and of the impetus given to improvements in his district by the good roads movement.

Mr. L. R. Ferguson, C.E., assistant secretary, Association of American Portland Cement Manufacturers, Philadelphia, read a paper on "Concrete Roads and Sheets." He pointed out that the opposition to good roads arose in many instances to the cost of maintenance. This cost was the greatest economic factor in the good roads movement. The speaker gave instances of the maintenance cost of concrete roads, showing that these were low, and that concrete was an ideal material for county highway purposes. Concrete, too, was reasonable in first cost. Horses were able to pull heavier loads over concrete roads than over those made of other material. The whole width of the road was available, and there was no tendency to use the middle of the road. The rapid increase of motor trucks had made concrete roads a necessity.

"Modern Bituminous Surfaces and Bituminous Pavements," was the subject of a paper by Mr. Arthur H. Blanchard, M. Can. Soc. C. E., Professor of Highway Engineering, Columbia University. He explained the methods of bituminous construction, bituminous surfaces, bituminous macadam pavements, bituminous gravel pavements, and bituminous concrete pavements,—and emphasized the importance of a clean surface before the imposition of bituminous material was made. The tendency in this country was to go a long period before the re-application of bituminous material. Many engineers were now practising an annual renewal of surfacing material. There was a difference of opinion between American and European engineers as to the necessity for the surface being dry, and his experience was in favor of dry surfaces. There should be a thorough compaction of broken stone before the application of bituminous material. Professor Blanchard also described the various machines in use, and insisted that engineers should see that the materials were suitable for the conditions under which they were to be used.

Professor A. T. Laing, University of Toronto, in a paper on the "Technical Training of Highway Engineers," alluded to the technical training of highway engineers on the European continent. On the American continent there had been, in the past, a disposition to pay little attention to this branch of engineering, with the result of waste and poor roads. In the United States remarkable progress had been made during the last few years, and in Canada they had made advancement, so that highway engineering was given a prominent place in the curricula of nearly all technical colleges throughout the Dominion. The status of the highway engineer must be recognized and the rewards for his services made commensurate with the high office he was called on to fill.

In his paper on "The Economy of a Vitrified Brick Road," Mr. W. P. Blair, secretary of the National Paving Brick Manufacturers' Association, Cleveland, Ohio, stated that the original cost of a brick road was not necessarily excessive. The cost of grading, drainage, bridging, and the entire preparation for placing thereon the artificial and wearing surface, should be alike for all types and was therefore no more expensive for a brick road than was required for the least expensive type of wearing surface. This necessary preparation in the case of a brick road bore a feature of economy that was well worth mention. It was not readily injured either from wear or tear or from any character of climatic influences. With the brick wearing surface placed upon it, ample protection for the durability of all the work incident to such preparation was afforded. The life of a brick roadway could be estimated to be much beyond that of a generation.

Mr. R. A. Meeker, engineer, Department of Public Works, State of New Jersey, read a paper on "Road Designing."

It was decided at Thursday's session to organize a permanent association with the object of holding annual Congresses. The following officers were elected. Hon President, Mr. U. H. Dandurand, Montreal; President, Mr. W. A. McLean, Toronto; first vice-president, Mr. D. Michaud, Quebec; second vice-president, Mr. O. Hezzelwood; the following were also elected as the members of a board of directors: Messrs. H. W. Pillow, Montreal; J. W. Kerr, Vancouver; Lieut.-Cal. W. N. Ponton, Belleville; Ald. R. J. Shore, Winnipeg; S. R. Henderson, President of Manitoba Good Roads Association; and Mr. J. Duchatel, engineer, Town of Outremont, P.Q.

Invitations to hold the next Congress were received from Toronto, Ottawa, Winnipeg, and Quebec, and these will be considered by the officers.

The relation of the motorist to the good roads movement was a prominent subject in the papers presented, Mr. O. Hezzelwood, chairman of the Canadian Automobile Federation, Toronto, and Mr. Robertson, secretary of the Ontario Motor League, read papers bearing on this question.

"The Bulk Handling of Cement" was the subject of a paper by Mr. H. M. Capron, president of the Marsh-Capron Manufacturing Company, Chicago. He stated that the use of cement in bulk was comparatively new. His interest and experience with bulk cement started with the mechanical problems involved in handling and storing the cement and other aggregates at the mixing plant, the measuring and conveying them to the mixer, and the handling of the concrete. Some of the large cement companies and a few progressive contractors had been studying this problem and it was significant that once a contractor had used bulk cement, he became one of the most enthusiastic converts. It required no little originality and a great deal of courage to depart from a custom of years' standing in any line of business, and such a departure must of necessity be founded upon logic which was absolutely sound. Mr. Capron described the system of handling bulk cement, pointing out that the elimination of the sack on the job would be a great boon. If besides securing this advantage, the contractor found himself relieved of a large item for labor in handling these sacks, both empty and full, there was no question that his best interests demanded that he use cement in bulk wherever possible.

In a paper on "Modern Highway Bridge Construction," Mr. L. E. Allen, C.E., consulting engineer, County of Hastings, Belleville, Ont., pointed out that good bridges were essential, as the tonnage over good roads would rapidly increase, thereby requiring more substantial bridges. Economy in good roads construction as well as in bridges could not be obtained by temporary or poor workmanship, and while it might seem to some that the initial cost of a good road or bridge was an indication of economical construction, too many instances of the false economy on low initial cost, with the resulting high cost of maintenance might be found to prove this statement. The other statements in the paper closely followed the lines of Mr. Allen's article in a recent number of the Contract Record.

Mr. Controller Church and Mr. D. Michaud, Deputy Minister of Roads, Quebec Government, were among the speakers, while the following papers were also read: "Modern Road Construction in the United States," by Mr. T. H. Boorman, secretary, American Society of Engineers, Architects and Constructors, N.Y.; "L'Association Internationale des Congres de la route, son organisation, son utilite et son role," by Mr. J. W. Levesque, M.L.A.

THE EXHIBITION

Not the least interesting section of the Congress was the exhibition of road machinery, etc., probably one of the most complete collections of machines, tools and material ever seen in Canada. While it had its purely publicity side, it also had an educational value, as those interested in road work were able to inspect the very latest and most economical methods of doing work.

The largest space was taken by Mussens, Limited, Montreal, who showed many lines of machinery. Here were displayed an enormous stone crusher, made by the Austin Manufacturing Company, of Illinois, together with other products of the same company, including a motor roller, grader, sprinkler, bins, sweeper, wagons and dump wagons. Mussens, Limited, also showed portable boilers, manufactured by the A. B. Farquhar Company, York, Pa.; gasoline engines and pumps, made by the Novo Engine Company, Lansing, Mich.; gasoline pumps, made by A. A. Parker, Waterford, N.Y.; Ruston, Proctor & Company's (Lincoln, Eng.) steam roller; Holman Bros. (Camborne, Eng.) rock drills; Hardy hammer drills, manufactured by the Hardy Patent Pick Company, Limited, Sheffield, Eng.; Meaford wheelbarrows, Sterling wheelbarrows; an electrically-driven Smith concrete mixer, equipped with an automatic side loader and auto water tank and power filling device; Meaford road and pick ploughs; and Barrows' & Company, Banbury, Eng., street sweepers—altogether a complete exhibition of road machinery.

The General Car and Machinery Works, Montmagny, Quebec, was another concern having a large exhibit. Their products have the merit of being all made in Canada, and comprised a complete outfit of road making machinery. The stone crusher is claimed to be the only type fitted with a jaw crusher running with a crank shaft and a connecting rod instead of an eccentric shaft, and a following roller. A feature of the crusher is the toggle shaft and sleeves which are easily replaced when the parts become worn. There is an all-steel-bin, screen and elevator, the whole outfit being put up on the ground in running shape. The equipment includes a steam road roller, a portable engine, steel sprinkler, steel plough and steel grader. A steel drill was also shown, together with wagons for spreading and carrying stone. The outfit shown has been purchased by the Town of Lachute, P.Q. The company was represented at the show by Mr. J. H. Paquet, the secretary-treasurer.

The Foss & Hill Machinery Company, Limited, were exhibitors of a Standard drum London concrete mixer, on trucks, with power loader, steam engine and boiler, also an automatic batch mixer with Standard gas engine. The London Concrete Machinery Company, Limited, of London, Ont., are the largest makers of concrete machinery in Canada.

One of the most tastefully decorated booths was occupied by the Aztec Oil and Asphalt Refining Company of Canada, Montreal. The product is of Mexican origin, and the booth was draped with material of Mexican design and coloring, and also decorated with souvenirs from that country. The company showed pictures of thoroughfares paved with Aztec asphalt and streets oiled with Aztec liquid asphalt. Several samples of the products were on view. Mr. J. R. Draney, general sales manager of the Interocean Oil Company, New York, Mr. Gordon Smith, Albany, N.Y., and Mr. E. Slade, Montreal manager, were in attendance.

The Marsh-Capron ("most mixing-least fixing") concrete mixer was shown by the Canadian Fairbanks-Morse Company. One of the points of this machine is the steel rail tracks fitted round the drum, which it is claimed run true and wear four or five times as long as cast iron tracks. The main drum gear is built in sections bolted in place. The Canadian Fairbanks-Morse Company also had on view the "Little Devil" mixer, and wagons made by the Glen Falls Wagon Company. A five-ton pitless scale, made by the Fairbanks Company, was another exhibit; while other lines were wheelbarrows, concrete carts and tools, pumps, wire and manilla rope blocks, and Milburn acetylene lights.

Concrete roads are coming more and more into use, and the Canada Cement Company had an exhibition illustrating the widespread area in which these roads have been laid down. By means of electrically-illuminated hand painted transparencies the various uses of concrete were shown. There were pictures of roads in the stages of construction, bridges, houses, etc. The company also exhibited a section of concrete pavement, giving the construction of transverse joints, method of reinforcing, and surface finish. Besides this there was a number of photos of Canadian streets, from Montreal to Edmonton, built of concrete. A novelty was an imitation rustic bench of concrete; every detail of a rustic birch bench had been followed out, and it was almost impossible to tell it from a bench of birch construction.

The Paterson Manufacturing Company, Montreal, had on view three samples of tarvia—one for road construction, another for reinforcing old roads, and the third for dust laying. There were also illuminated transparencies of roads in course of construction and finished, on which tarvia was used.

The Pedlar People, Limited, had some of their widely-known specialties on show. Thus there was material for all-steel buildings, for corrugated iron culverts, and Clinton electrically-welded wire used in the Clinton system of fireproof construction and concrete reinforcement, which has now been in use for some years.

There are now about 300 Troy wagons doing service in Montreal. The agents in the city are McNally & Company, Limited, who had on view one of these dump wagons. Mr. H. C. Tattersall, who is one of the Troy Waggon Works Company's special representatives, was looking after their interests at the show. At the booth there were many photos of the company's various types of waggons.

The Dunn Wire-Cut-Lug Brick Company, Conneaut, Ohio, were showing some of their productions and photos of roads where the bricks are used. This company are among the important manufacturers of paving brick in the United States, and have the largest continuous kiln in the world; with the additions now being made it will total 3,300 feet. Several Canadian jobs have been completed, amongst them being one in Toronto. The Montreal agents are the Stinson-Reeb Builders' Supply Company, and the Toronto agent G. W. Essey. The brick makes a firm highway, and allows the grout to get down, also giving a smooth surface. It is in extensive use in the United States.

Alexander Bremner, Limited, is one of the oldest supply houses in Montreal. The products exhibited included drain pipes, contractors' wheelbarrows, cement tools, paving bricks, etc.

A large variety of samples of road-making materials was to be seen at the booth of the Elder Ebano Asphalt Company, Limited, of Montreal. These included "Mexican Ebano," Mastic asphalt, rock asphalt, artificial blocks of all shades, granite, "Danforth" pink stone, bricks of all colors, and "Ebano Asphalt."

A new firm to the Dominion is the Decauville Flexible Armour of Canada, of Montreal. They sell a patent protection for dykes, embankments, etc., which consists of a strong network of cement bricks, with two holes in them. The bricks are connected together by wires (made of steel for fresh water, and of aluminium for salt water) by means of laying keyboards or gauges which enable the workmen to construct the network making up the armour. The company had on show samples of the brick and of the completed network.

Baker-Barron, Incorporated, are manufacturers of road machinery, including "Strait's" caterpillar tractor, the 20th century sweeper, 20th century four-wheel scraper cyclone ditcher, and the two-can carrier. Some of these were on show.

Other exhibitors were the Thomas Davidson Manufacturing Company, Limited, Montreal (enamelled steel and lithographed metal signs, street names, etc.); the Albion Motor Car Company of Canada (a gasoline dumping truck); Jones & Glassco (Foden Steam Wagon); Canada Creosoting Company, Limited (creosoted wood paving blocks, railroad ties and bridge trenches); British American Oil Company, Montreal (petroleum products, asphaltic road oils); J. I. Case Threshing Machine Company (road machinery); and Imperial Oil Company (road oils and asphalt binders)

Through the courtesy of Mr. W. A. McLean, the Ontario Government exhibited a series of miniature models, showing the development of road building.

During the evenings representatives of some of the exhibiting firms gave talks on their various products. The speeches were made the more interesting by means of moving pictures and lantern slides. Mr. Van Scoyoc, of the Canada Cement Company; Mr. De Wind, of the Austin Manufacturing Company; and Mr. P. P. Sharples, general manager for the United States and Canada of the Paterson Manufacturing Company, were among those who spoke.

LETTERS

Waterproofing Problems

Editor Contract Record:

In a recent issue of the Contract Record (April 8), I notice an interesting article on Waterproofing, by Mr. L. G. Mauer. In his article Mr. Mauer recommends mixing a chemical solution with cement mortar. I shall be glad if you will kindly inform me what this chemical is and where it may be obtained.

Yours very truly,
A. E. CARTER.

At our request Mr. W. H. Evans, waterproofing expert with Messrs. Dartnell, Limited, Montreal, offers the following solution:

"In making concrete block the cement should be waterproofed before it is added to the sand, or other aggregates according to the waterproofing manufacturer's directions. Waterproofing should be of a colloidal nature which will lubricate, or assemble the aggregate into one dense mass. The cause of the free lime appearing on the surface is due to uneven cementation caused by the quick evaporation of water before the cementation process is complete. The colloidal waterproofing will retain a certain amount of excess water in the mass until the limes existing therein are thoroughly fed. Then it creates by the evaporation of this water a chemical action, or crystallization, which closes all pores or fibrous channels which otherwise would allow the free lime to be drawn to the surface by the moving air. Besides, it will make the blocks absolutely waterproofed and impervious to the weather."

Mr. Evans suggests the use of "Toxement" and informs us that this material is now being used on a concrete foundation for Messrs. Canadian Vickers, Limited. The building is on the St. Lawrence River and will have to stand an eight-foot head pressure. The watertightness of the building is guaranteed for five years—a proof of the faith which the proprietors have in the qualities of the material.

Personal Mention

Mr. Robert J. Marshall has been appointed town engineer of Trenton, Ont.

Mr. Frank Barber, consulting engineer, Toronto, and Engineer to York County, has been engaged as township engineer of Etobicoke.

Mr. A. R. Moore, resident engineer, Kettle Valley Railway, Kelowna, B.C., has become an associate member of the American Society of Civil Engineers.

Mr. W. W. Smith, assistant engineer, Grand Trunk Railway, Montreal, Que., was recently elected an associate member of the American Society of Civil Engineers.

Mr. McC. P. Blair, city engineer, St. Boniface, Man., has been transferred from the associate to the membership section of the American Society of Civil Engineers.

Mr. F. L. Macpherson, municipal engineer, Burnaby municipality, Edmonds, B.C., has been elected an associate member of the American Society of Civil Engineers.

Mr. Wilfred Brereton, who is a 1903 graduate of the School of Practical Science, Toronto University, has been appointed City Engineer of Winnipeg, at a salary of $6,000 a year. Mr. Brereton has done considerable engineering work in Toronto and Hamilton during the last ten years.

Mr. J. E. Pennybacker, until recently secretary of the American Highway Association, has rejoined the Office of Public Roads in the capacity of chief of the division of road economics.

Mr. George H. Herrold, Assistant City Engineer of St. Paul, Minn., has been selected to represent that city at the international conference on city planning to be held in Toronto, Ont., on May 25 to 27.

Mr. Leonard Andrews, M. Inst. C. E., managing director of the Canadian British Engineering Company, Limited, has arrived in Winnipeg from England to succeed as Canadian manager Mr. Reginald Porter, who returns to London, Eng., to resume the management there.

Mr. Chas. G. Toms has received an appointment as general manager of the Toms Contracting Company, Limited, Toronto. A graduate in Civil Engineering of the University of Toronto, Mr. Toms has had considerable experience in construction work, mainly in concrete and building construction.

Mr. D. H. Mapes has been appointed Superintendent of Building Construction for the Canadian Pacific Railway, according to an announcement from the head office of the company at Montreal. For many years Mr. Mapes was vice-president of J. V. Schafer, Jr., & Company, a well-known contracting firm of New York City. He entered the service of the Canadian Pacific Railway in July, 1912, as assistant to Mr. F. L. Ellingwood, who was then superintendent of building construction. Mr. Mapes' appointment to the office follows Mr. Ellingwood's resignation.

Mr. J. W. Evans, who was appointed recently as City engineer and manager of waterworks, street and sewer departments, of Belleville, Ont., has had an extensive experience in railway and mining engineering work, and has also served as town engineer for Deseronto, Ont. He was formerly chief engineer for the Bay of Quinte Railway Company, and built that line between Deseronto and Napanee, and between Tweed and Bannockburn. He also built the extension of the Central Ontario Railway between Ormsby and Bancroft. He conducted a general civil and mining engineering practice at Cobalt from 1906 to 1909, and from that time up to April 20 of this year was connected with the engineering and surveying firm of Evans & Evans, of Belleville and Thornton.

At Westmount last week there occurred the death of Mr. John Laurie, who for forty years was connected with the engineering firm of John Laurie & Brothers and later with the Laurie Engine Works. Mr. Laurie was born in Montreal over eighty years ago.

Mr. John Graham Steacy, a railroad contractor of continental reputation, died at Brockville on May 8, aged 77. In early life Mr. Steacy was associated with his father in the erection of passenger stations and engine shops along the line of the G. T. R. He was senior partner in the firm of J. G. Steacy & Company, which built the first fifty miles of the European & North American Railroad running out of St. John, N.B. He also had important contracts on several railroads in the United States.

Senator William Gibson, who died recently at Beamsville, Ont., was for over twenty years in charge of masonry construction on the Grand Trunk system in Canada. He also took an important part in bridge construction, having supervised the building of the approaches and portals to the Sarnia tunnel, and the Victoria Jubilee bridge at Montreal.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

A new storey is to be added to the Montreal City Hall, and the offices are to be re-arranged. The engineers' department is to have new quarters.

Operations for constructing a highway from Sherbrooke, P.Q., to the boundary line have been commenced by O'Brien & Doheny, contractors, Montreal.

The Toronto Harbor Commissioners have several dredges in operation at present in connection with the extensive harbor improvements for which several contracts have already been let.

A Trade and Labor Congress is to be held at St. John, N.B., in September. About 350 delegates will attend from different parts, including representatives from Great Britain and the United States.

A bill to create a Water Power Commission, consisting of three commissioners and a secretary, to investigate the possible source of water power for hydro purposes has been entered in the Nova Scotia legislature by Premier Murray.

There is a good deal of constructional activity in Hamilton at present. Two business blocks are in course of erection and numerous other buildings are contemplated. Street improvements are also to be pushed forward, notably the asphalt paving of Balmoral Avenue.

The city of Hamilton has another industrial concern in the newly-incorporated National Rubber Company, Limited. This firm, which has a capital of $500,000, will manufacture all kinds of rubber goods. The local men interested include Dr. George Weing and Mr. Frank E. Walker.

The Montreal Board of Control has recommended to the city council the construction of a tunnel under the Lachine Canal, at the point where it is crossed by the Wellington bridge. This is said to be the only means of relieving the traffic congestion existing in the Point St. Charles section of the city.

Mr. G. B. Reynolds has removed from the Coristine Building, Montreal, to Guarantee Building, Beaver Hall Hill. Mr. Reynolds is the eastern representative of the Trussed Concrete Steel Company, Trus-Con Laboratories, Northwestern Terra Cotta Company, and President of the Hadrian Flooring Company.

Operations on the filling in of Ashbridge's Bay, part of the undertaking to improve the Toronto water front, have commenced by the contractors, the Canadian Stewart Company. This particular work will take four years to finish, and about 14,000 piles will be driven. The Harbor Commission system of pile driving will be the use of a powerful blast of air forcing the piles down, while the Canadian Stewart Company will use a battery driver which will place four piles in position at a time.

The Public Utilities Commission at Montreal, Que., has decided that the city conduit plans provide for insufficient ventilation of the St. Catharines Street section. The Commission's objection will be laid before the Electric Service Commission. It was announced by Mr. J. L. Perron, K.C., representing the Montreal Public Service Company, that $400,000 would be expended by the city on laying the St. Catharines and Bleury conduit, and that the different companies interested would spend $600,000.

At Ottawa a construction company has been formed to build working men's houses to sell on the easy-payment system. The company will have a capitalization of half-a-million dollars. It is intended to manufacture nearly all the building materials and a brick plant will be started by the new firm near the cement works in Hull, Que. Negotiations have been completed for quarries of Nepean sandstone and ordinary limestone near the city. Other equipment is to include a lumber department, planing mills, and cement block plant.

With the object of giving additional encouragement to the construction of dry docks in Canada, the Dominion parliament passed a resolution recently, on the motion of Hon. Robert Rogers, providing that the subsidy payable in respect to first-class dry docks, under Section 8 of the Dry Docks Subsidy Act, be increased from 3½ per cent. to 4 per cent. per annum of the cost of works to be carried out during the next thirty-five years. This increased percentage is deemed necessary in order to encourage capitalists to invest in Canadian dry dock projects.

An International Conference on City Planning will be held in Toronto from May 25 to 27. The Ontario capital has the distinction of being the first Canadian city to receive the conference, which this year will become international in scope and character. A grant has been obtained from the Dominion Government, the Ontario government and the city of Toronto also contributing. City planning is thus recognized to be of national, provincial and municipal interest. An address will be given by H.R.H. the Duke of Connaught, who will open the Conference.

The sub-committee of the Toronto Board of Works is considering the question of water rates in the city. The levy of a special tax at three cents a foot frontage on all property in the city, providing a fund to lay water mains, is one of the suggestions put forward on the ground that the mains should be laid as local improvements. There are about sixty miles of Toronto streets without water mains, and the adoption of this suggestion would mean the availability of 663,600 feet of frontage for taxation. It is urged in opposition of the frontage tax that such a scheme would involve a heavy expenditure in certain sections of the city.

WESTERN CANADA

The Roman Catholic denomination intends to erect a substantial college in Regina, Sask., and work on the structure will probably be commenced during the present year.

The city of Regina has decided to go ahead with the building of a police station at a cost of $147,440. The contract has been let to the Frid Lewis Company, which recently opened an office in Regina.

Mr. Horwood, architect of the new block to be erected at Victoria, B.C., for the Hudson's Bay Company, visited the centre of operations recently and expressed satisfaction with the progress of excavation. The substratum of the site has proved peculiar in formation, and delay has been caused by unexpected difficulty in reaching rock bottom in the excavation at the northwest corner. The pouring of concrete will commence in a few days. Most of the steel is already on the job.

The firm of Wettlaufer Bros. of Toronto, manufacturers of concrete mixers and other heavy machinery, have opened a branch in Regina, Sask. They have secured temporary quarters in the old Monarch Lumber Company's warehouse, but will shortly erect a first-class warehouse of their own. The branch at Regina is the only one west of Winnipeg, and will control all the business in Saskatchewan, Alberta and British Columbia. A. E. Hodgert will be the local manager

Word has been received from London, Eng., from the emissaries of the Burrard Inlet Tunnel and Bridge Company, that the firm of Sir John Wolfe Barry, who prepared the original plans under an agreement to have the inspection of construction of the bridge across the Second Narrows, have agreed to relieve the company from the contract. This leaves the latter free to accept one of the alternative bids submitted in April last. Most of the tenderers declared that as good a bridge could be constructed for a much smaller sum if the plans were altered slightly.

Considering the backward conditions of 1913, the prospects for building in Regina, Sask., this year are exceptionally good. Many big buildings have already been contracted for, some of which are even now under construction. The Grand Trunk Pacific Hotel and station will in all probability be completed during the present year. The excavation for the hotel was completed last year, and the footings sunk, so that everything is in readiness for the erection of the building without delay. In addition to the building work the city has a progromme of local improvement works which will require an expenditure of well over $2,000,000, classified as follows:—Water works, $360,000; water main extension, $127,752; domestic sewer extensions, $142,145; storm sewer extensions, $170,000; sewage disposal works, $61,520; street railway extensions, $250,000; pavement, $452,946; sidewalks, $65,000; electric light and power, $404,000.

The Public Works Department of British Columbia is asking bids on a large bridge to be erected over the Pitt River. The location of the bridge is at Port Coquitlam, about twenty miles east of Vancouver, and is on the route of the Dewdney Trunk Road. It will cross the Pitt River about one-fourth of a mile upstream from the Canadian Pacific Railway Company's bridge. Borings have been made across the site, which show that for a depth of 150 ft. the ground is composed of very light clay or mud, interspaced with beds of gravel or sand. The greatest depth of water at ordinary low tide is about 50 ft. and at ordinary high tide about 6 ft. more. The substructure will consist of nine concrete piers, all of which will have concrete shafts resting on timber cribs, but the two outermost piers will have timber piling in addition. At both ends of the bridge there will be timber trestle approaches, 540 ft. in length at the west end and 270 ft. at the east end. The guide pier for the swing span will be of timber piling.

The superstructure will consist of seven steel spans. The clear width of roadway on the bridge will be 16 ft., and on the trestle approaches 24 ft. The swing span will give a clear opening of 93 ft. on either side of pivot pier. When closed it will have a clearance of 24 ft. between mean high water and the underside of truss. The deck of the bridge is to be arranged to admit, at some future time, of laying steel rails for electric cars. The estimated cost of the completed bridge is $450,000. The contract for the removal of the steel spans from the Canadian Pacific Railway Company's bridge, which have been purchased for $70,000, and the placing of them on the piers of the highway bridge, has already been let.

Canadian Railroad Development

Mr. David McNicholl, vice-president of the Canadian Pacific, is visiting the west to push forward work on the construction of the Kettle Valley Railway in B. C.

At Victoria, B.C., about 4,000 men are at work on the construction of the Pacific Great Eastern railroad, according to a statement made a few days ago by the president of that railway, Mr. A. W. Stewart, who is also a partner in the contracting firm of Foley, Welch & Stewart. Recently several further contracts were awarded for the construction of different sections of the Pacific Great Eastern, Messrs. Hackman & Moore being given a section of ten miles between Kelly Lake and Clinton. Other contractors who are carrying out additional sections include Messrs. Welch & Kennedy, Rankin & Kellett, and Madden Bros.

The Dominion Government is building a line in northeast Manitoba from the Canadian Northern Railway to Port Nelson, and the provincial government of Manitoba is proposing a line north from Winnipeg to the same point. The provincial government of Ontario proposes to extend the Temiskaming & Northern Ontario Railway to James Bay (the southern arm of Hudson Bay), with a terminal at the mouth of the Moose River, at the southwest corner of the bay. The Canadian Pacific Railway is said to be contemplating an extension of its Kippewa branch north from Kippewa, Ont., to James Bay. The Temiskaming & Northern Ontario Railway already extends from Toronto to Cochrane, Ont., on the Canadian Transcontinental Railway, and has had investigations made as to conditions for establishing rail and water terminals at Moose Harbor, the mouth of the Moose River.

Publications Received

"Foundations of Bridges and Buildings," by Henry S. Jacoby, Professor of Bridge Engineering, Cornell University, and Roland P. Davis, Professor of Structural and Hydraulic Engineering, West Virginia University. Published by the McGraw-Hill Book Company, Inc., New York City. Price $5.00 net.

The authors treat in a systematic manner the entire subject of foundations for bridges and buildings, confining their observations almost exclusively to American engineering practice. Careful attention is given to piles and pile-driving, the matter presented in this connection being calculated to be particularly helpful to the young engineer. It is interesting to note a chapter on pneumatic caisson practice by Mr. T. Kennard Thomson, an experienced consulting engineer and a graduate of the University of Toronto, now in practice in New York City. Mr. Thomson's experience and observations should be helpful to all engineers and contractors of lesser experience. There are three chapters on Piers and Abutments. The book contains upwards of six hundred pages and is profusely illustrated. The headings of the various chapters are as follows: Timber Piles and Drivers, Driving Timber Piles, Bearing Power of Piles, Concrete Piles, Metal and Sheet Piles, Coffer-dams, Box and Open Caissons, Pneumatic Caissons for Bridges, Pneumatic Caissons for Buildings, Pier Foundations in Open Wells, Ordinary Bridge Piers, Cylinder and Pivot Piers, Bridge Abutments, Spread Foundations, Underpinning Buildings, Explorations and Unit Loads, Pneumatic Caisson Practice, References to Engineering Literature.

The keen competition between brewing companies has brought about the most careful study of every structural detail tending to improve quality or reduce the cost of production. The Home Brewing Company, Newark, has made a special study of these matters and, as a result, has placed a contract with the H. W. Johns-Manville Company, of New York City, for the insulation of those departments requiring the most accurate regulation of temperature. The order involves complete insulation with J-M Pure Cork Sheets. These are said to contain more "dead air" cells than any other insulation on the market. They are non-absorbent, never rot or crumble, and last as long as the building they insulate.

Development of the Neponset Wallboard Industry

In 1795 George Bird, founder of the firm of Bird & Son, inaugurated the Neponset wallboard industry, which ever since has continued in the hands of the same family. This is believed to be a record in the paper and felt making history of America. From modest beginnings there has grown the present extensive organization which has two mills operating in Canada, three in the United States, besides warehouses and sales offices covering both countries and agencies in all parts of the world. The daily capacity of the mills is 300,000 lbs. of paper, 600,000 sq. ft. of roofing, and 800,000 sq. ft. of waterproof paper. The company buy their raw materials direct from home and foreign markets, and manufacture their products throughout with the most exacting system of tests, which latter are attended to by special departments. In using Neponset products for building purposes the example is followed of many large railroad systems who for years have been extensive users of the material, one system alone taking 15,000,000 sq. ft. in a year.

Neponset wallboard, the Bird substitute for laths and plaster, is made to ensure the maximum tensile strength. To eliminate the possibility of warping, which is said to result from the absorption of moisture by ¼-in. fibre boards, Neponset wallboard is claimed to be thoroughly waterproof on each surface, thus preventing moisture from getting into the board. An attractive finish is added to the surface; in fact it is made in three different finishes. Neponset wallboard can be applied immediately, a feature which commends it as an efficient substitute for laths and plaster.

Neponset proslate roofing, which is Neponset Paroid plus some additional treatment, is held to be the highest development which ready roofings have ever reached.

In addition to Neponset roofings and Neponset wallboard, Bird & Son are also manufacturers of floor covering paints, insulating paper, waterproof building papers, fibre cases, etc.

The Seattle, Wash., Branch of the H. W. Johns-Manville Co. was recently awarded the contract for supplying cork sheets for the Mainland Ice & Cold Storage Company's new plant at Vancouver, B.C. This product, which is known as J-M Pure Cork Sheets, is claimed to be the standard material for cold storage insulation. The process of making these sheets is a most interesting one and consists, in part, of compressing pieces of cork in moulds at a temperature of 500 deg.

We have just received from the Herbert Morris Crane & Hoist Company, Limited, Toronto, a copy of their new Bulletin B5, which is devoted entirely to the various types of travelling trolleys made by the firm. These trolleys are of many patterns and run either on a flat-bar track or on the lower flange of an ordinary steel I-beam. Some are prepared for short straight runways, while others, containing suitable swivels, are flexible in a horizontal direction, and thus permit of the use of curves or "bends" in the track. The bulletin contains much practical information of immediate interest to all users of this kind of equipment. The illustrations, diagrams and tables of dimensions and prices are arranged in a handy form.

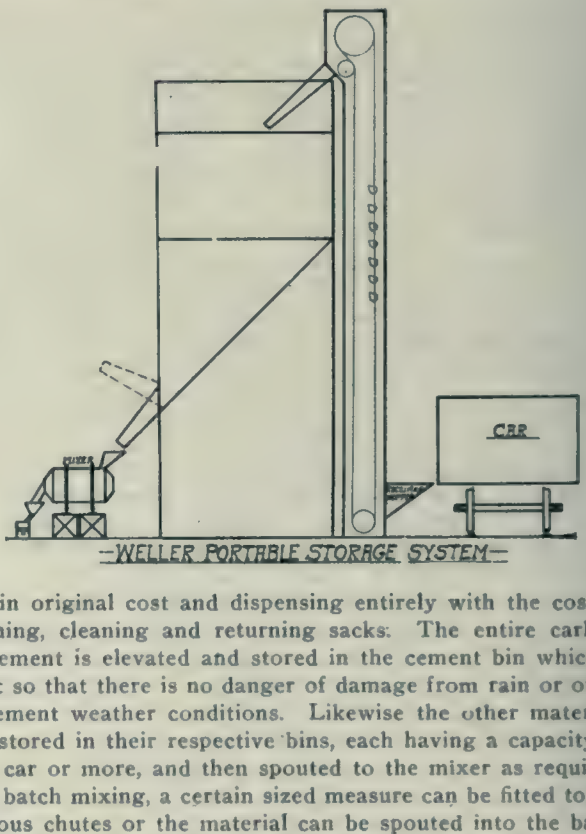
Portable Storage System

Concrete contractors and road builders will appreciate the portable storage system for handling cement, sand, gravel and crushed stone, illustrated herewith. The storage and handling of these materials in construction work frequently becomes a serious problem.

Cement must be stored in a house or under cover where it will not be damaged by the weather. The sacks must be paid for by the contractor who is allowed a pro rata amount for the sacks returned in good condition. In addition to the cost of opening sacks, there is usually a loss through injury and the additional expense of cleaning, bundling up and transportation charges back to the manufacturer.

Crushed stone, gravel and sand can, of course, be piled up on the ground. This means placing of planks, which are usually no good afterwards, or else a certain amount of loss due to the material working into the ground. Frequently, also, there is more or less bother and confusion in climbing over these piles and certainly considerable expense in putting into the piles and rehandling to get material to the mixer.

By using the Weller portable storage system, cement can be purchased in bulk, thus effecting a considerable saving in original cost and dispensing entirely with the cost of opening, cleaning and returning sacks. The entire carload of cement is elevated and stored in the cement bin which is built so that there is no danger of damage from rain or other inclement weather conditions. Likewise the other materials are stored in their respective bins, each having a capacity of one car or more, and then spouted to the mixer as required. For batch mixing, a certain sized measure can be fitted to the various chutes or the material can be spouted into the batch hopper.



—WELLER PORTABLE STORAGE SYSTEM—

For continuous mixing, automatic feeding devices can be attached to the spouts, regulated to deliver varying amounts from the different bins at the same time. By this arrangement, maximum capacity can be reached, as the unloading from cars can be accomplished at the most convenient time and a large supply of material is constantly on hand and available by simply operating a lever.

After finishing the job, the equipment can be taken down, shipped to another point and quickly re-assembled. The machinery can be operated by motor, gas or steam engine, or by any other available power.

These storage systems can be built entirely of steel, of wood, or of a steel frame with wood bins. The design and mechanical equipment are the product of The Weller Manufacturing Company, of Chicago, Ill.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 June 3, 1914 **No. 22**

Principal Contents

Functions of the Engineering Society 703

Engineering Topics in the Old Land 704-5
London Eng., Correspondence of the Contract Record

Purification of Water by Ultra-Violet Rays 705
By Max Von Recklinghausen

Report of Sixth National Conference on City Planning, Toronto 706-7

The Nature and Utility of Building and Ornamental Stones 708-18

Proportioning Concrete Aggregate 719-21
By F. C. Snow

Estimating the Cost of Earthwork and Concrete Construction 722-8
By L. B. Merriam

Constructional, Personal and Industrial News 729-33

The American Association of Portland Cement Manufacturers have decided to hold their convention in Montreal next September. Mr. F. B. Jones, General Manager of the Canada Cement Company, who attended a recent meeting of the Association at Philadelphia, states that the cement industry on the other side of the border has suffered little from the business depression. Cement road work is making great headway and over 5,000,000 bbls. of cement will go into country roads throughout the United States this season. Speaking of Canadian conditions, Mr. Jones states that the demand for cement in this country has been well maintained and that the sales last month were on a par with those of May, 1913.

The Functions of the Engineering Society

THE Engineering Society as an Influence in Education was the subject of an address by Mr. Albert Reichmann before the Western Society of Engineers, and the observations put forward offer plenty of scope for editorial discussion. As Mr. Reichmann pointed out, the training that an engineer receives at a university is so broad that to a limited degree it enables him to commence the practice of almost any branch of his profession. But so very broad is the field of engineering and so keen the competition in every line that in order to excel an engineer must choose a comparatively narrow field of activity in order that he may become thoroughly proficient therein. The progress of the world is so rapid, the field of human achievement so complicated that a man must be unusually able to anywhere near keep step with the onward march of events.

An engineer, therefore, must specialize along certain lines if he hopes to attain success; he must not only give the best that is in him to his immediate calling, but he must also study and observe the relation of his work to that of the other lines which have a bearing thereon. For instance: the expert in the construction and maintenance of railroad track should not only master the subject of track construction, but he must also watch the developments that are taking place in the motors and the rolling stock which pass over the road.

We have a notable example of this in connection with the development of the steam engine. After it was generally believed that this machine had attained its maximum efficiency it was found that it was not suitable for generating electricity, and as a result the steam turbine was evolved.

It is very evident, therefore, that an engineer in order to be successful cannot be a recluse. He must associate with his fellow engineers. Now he can best secure such association through the technical societies. The meeting of engineers under conditions where all are on a common footing fosters a spirit of kindly co-operation and helpfulness which binds them together and makes each of greater usefulness to the other. It is only by wide co-operation that the best advancement can be made in engineering science and achievement.

As in the legal profession the decisions of the judges are entered and published, thus forming a basis of precedent for future use, so also it is desirable that records of important engineering work should be published in order that we may benefit by the experience of others. Many of the larger engineering undertakings are the result of the co-operation of several engineers who are proficient in their respective fields. It is, of course, customary to have a chief engineer at the head of any important enterprise, nevertheless the work which he supervises is usually the product not of himself alone but of those also who are associated with him. It frequently happens that on large undertakings experts in various lines of the work are employed and the duty of the chief then consists in determining the general scope of the work, the special features being developed by these experts in their respective lines. For instance: the building of a large steel plant requires expert metallurgical engineers, electrical engineers, mechanical engineers and structural engineers. It is manifest then that as the work becomes of great magnitude, it is most important that accurate records of the same should be made available. These records can best be promulgated through the proceedings of technical societies. Such published proceedings find their way around the world.

Technical societies also afford the younger engineers the opportunity of securing the experiences of older engineers, resulting from the fact that they are permitted to participate on an even footing in the discussion of the papers presented.

The older engineers should and generally do take great interest in the work of the student engineers, and the latter may be greatly profited thereby.

The influence of the technical society and its value to the professional engineer is probably even greater than to the student. The practicing engineer is no longer under the guidance of professors and instructors and his opinions and development of ideas must be largely molded by those with whom he associates.

To be well educated involves not merely the mastery of knowledge, statistics and current events, but also embodies the broadmindedness which can see the justice and good sense of the other fellow's opinions and beliefs. A comprehensive judgment of various views and solutions is only possible through the assimilation of ideas and associations such as an engineering society offers.

In the technical societies the various steps of mechanical development are depicted both from the practical and theoretical standpoint. They afford the engineer an opportunity to supplement his own knowledge by the experience of his fellow engineers. They afford him the opportunity to present to the world what he himself has accomplished and to receive criticisms and suggestions from his fellow men. Resulting from the discussion of the various subjects which are presented the engineer learns to appreciate the benefits of co-operation, by means of which both the giver and receiver are greatly benefitted.

Engineering Topics in the Old Land

Conservatism in Great Britain and its Effect in Retarding the Progress of Sound Municipal Improvement

By the London, Eng., Correspondent of the Contract Record and Engineering Review

THE difference between conservatism and conservation is not perhaps at once apparent. Both words have the same derivation, and preservation is their elementary meaning; but there is a very distinct difference between them—a difference which it is important to note. Conservatism is defined in the dictionaries as "the being conservative of what is established," conservation as "the keeping of a thing in a safe or entire state," and it is at once clear that while the latter is a good attribute the former is but little removed from a bad one. The word conservatism should have no place in an engineer's vocabulary. An engineer must have no concern with what is established merely because it is established. Disestablishment is more in his line, for his work is essentially to see that things are kept in a safe and entire state. Whoso would be a man must be a nonconformist, says Emerson, and the greatest engineering creations of the world have been the work of the nonconformer, the man in whose ears the old shibboleths rang false and who was unafraid in the face of criticism and opposition. The recent plethora of papers and articles on concrete road construction must be held responsible for this somewhat lame preamble, but among the many ways in which the English engineer exhibits his conservatism there is none so patent as his unreasoning opposition to this form of carriageway. Scratch away the cuticle of an engineer, it may be said, and the "cutis vera" will not be reached until a more or less tough layer of conservative sub-integument has been removed. Some such layer is undoubtedly necessary—if only as a depository for first principles, formulae, axioms, fundamental truths and so on—but the more absorptive and porous it is the better for the individual, and, incidentally, for his clients.

Concrete Roads

Concrete carriageways are practically non-existent in England; anyway the writer has never seen one. Mention such a form of construction to the municipal engineer and he will probably say: "Oh, they're no good." Ask him if he has had any experience of them, if in fact he has ever seen one, and he will reply: "No, and I don't want to." Pursue the matter, and explain to him that quite civilized communities in the western hemisphere hold them in high estimation and use them largely, and he will close the argument with a disparaging remark about American practice and "we don't want that kind of thing here. It may be all right for them"—the final word embracing in a comprehensive sneer the whole of the peoples of the United States and Canada. In a recent paper delivered before the Canadian Society of Civil Engineers, certain advantages of concrete roads were set forth. It was claimed for them that they were low in first cost, averaging only about 10 per cent. more than water-bound macadam, that they were easily and cheaply maintained, that they were dustless and sanitary, and that they afforded good foothold for horses and due grip for motor vehicles. The English municipal engineer will have none of it. No Canada roads for him—no, not even the humblest thoroughfares! He is adamant, and, it must be confessed, not a trifle idiotic.

Brick Roads

Having never seen a concrete carriageway, the writer is quite as open to conviction that any such construction must prove a failure as that it has proved a success. Mr. Logan Waller Page confessed (in a paper read before the Association of American Portland Cement Manufacturers, of all people!) that he had "never yet seen a road built of Portland cement concrete that he considered altogether a success." This was in 1910, and Mr. Page may have changed (or at least modified) his views since then; but the fact remains none the less that Mr. Page had had experience of concrete roads and was qualified to speak upon them. Brick carriageway pavements lie under practically the same ban in England, but with more reason, inasmuch as they have been tried and found wanting. Their maintenance expenses are high and they are said to be execrable for the cyclist, while the heavy motor vehicle with iron-tyred wheels, or even the lumbering steam roller (despite its spreading of weight), may prove "so destructive as to crush (or at least severely damage) every brick in its track." Still, there are many miles of brick carriageways in existence which admirably answer the purpose for which they were laid, and there is scope now in England for the conduct of a series of real, live experiments. Bricks are used largely for crossings and channels in macadamized roadways, and the writer's experience of those laid for these purposes has been particularly happy. Leaving aside the question of brick carriageways, however, there can surely be no earthly reason—save unreason—why concrete carriageways should not be accorded a fair, full and extended trial. Failure is to be courted almost as much as success, if only for the setting to rest of a constantly recurring problem, and failure is even to be courted for its own sake as the bed-rock of experience.

Reinforced Concrete

Reinforced concrete has afforded another field for the display of British conservatism, and it was scarcely an edifying experience to witness the delight with which the engineering forces welcomed the inevitable failures in the earlier days of this form of construction. It was regarded as a craze, a temporary innovation, a red herring across the true and only road to constructional perfection. But, as has been the case almost throughout the history of the world, commercial interests predominated, and not commercial interests alone, but (shadow of the Union Jack) interests which must be qualified by the expression "foreign." The English engineer did not take it lying down. He was very much on the alert, but he carefully blindfolded himself and stuffed his ears, and his protest lacked force. Government departments were for many years his mainstay, fighting his battle (against foreign foes) tooth and nail, by-law and regulation. Even when certain departments had been won over and were themselves using the material—their officials having at last managed to grasp the principles of construction—outsiders were practically prohibited from doing so. But foreign persistence conquered in the end; and the time is not far distant when by-laws throughout the country will contain clauses more or less prohibitory. Such an expression certainly sounds somewhat of an anomaly, but in conservative communities prohibition is synonymous with qualified acceptance, while the drawing up of impossible regulations marks the incipient stages of absolutely untrammelled freedom.

The Trade and Technical Paper

ONE of the most conspicuous developments in the increasing specialization of business is the rapid rise of trade and technical papers. Time was when these publications occupied the lowest rung of the publishing ladder, but now they have begun to climb.

The civil engineer of our grandfather's day was merely a surveyor and the contractor occupied a much lower plane. To-day the engineering profession has been split up into many specialties and the contractor plays a part of ever-increasing importance. This development has been followed by the growth of powerful engineering-contracting periodicals which may be said to be pioneers in the newer and better trade and technical journalism.

In the field of business there has been the same increasing demand for special knowledge. While reading and studying were once the avocations of a business man, they are now a necessary part of his day's routine. He has ceased to read merely for amusement or to increase his personal culture and has turned to the literature of trade.

Engineering-contracting has problems that demands an individual organ of discussion. In catering to this need the technical-trade paper will fill a high destiny and only such a journal as places editorial sincerity above all other considerations will survive.

Purification of Water by Ultra-Violet Rays*

FREEDOM from turbidity is one of the first requirements for a water which is to be sterilized by ultra-violet rays. When any suspended matter is interposed the bastericidal action cannot occur, for the microbe is in the shadow. In most cases it is necessary to filter the water before submitting it to the action of the lamps. As color in solution will absorb ultra-violet rays to a certain extent it is evidently better to free the water from coloring material before submitting it to the rays.

Sometimes water with little suspended matter may be more difficult to sterilize than water with far more suspended matter. Suspensions of purely mineral nature which do not enclose any microbes and to which few microbes are attached handicap the sterilization of the water very much less than suspended particles in similar water which are heavily covered with microbes and particularly so if microbes are enclosed in these particles, because it is then most likely that a very long and repeated exposure to the rays will be necessary to penetrate to the enclosed germ life. If the suspended matter is of smaller size than the germs, like colloidal clay, it acts more or less like color in solution, demanding simply some more illumination than clear water.

From the economical point of view the condition in which the water is submitted to the rays is evidently of the greatest importance for the ultra-violet ray sterilization system. Physically ideal water, or water without suspended matter, turbidity or color will need very little power in ultra-violet rays to become sterile.

Smaller installations are being equipped usually with paper pad filters. In large plants, naturally, the filter question is an engineering proposition, as is the question of choice between mechanical and slow sand filters. It seems that if the latter are chosen they can be speeded up to higher rates than is safe for biological filtration alone and still give a physically pure enough water for ultra-violet ray treatment. At the Luneville plant in France the water is filtered at three times the rate of biological filtration for that particular kind of water. In other plants the sand filters have been speeded up to 10,000,000 gal., 12,000,000 gal. per acre and we even tried with fair success 25,000,000 gal. per acre followed by ultra-violet ray treatment.

Operating Costs

Operating costs will vary with the size and the running hours of the plant and the coefficient of safety for the ultra-violet ray treatment. According to the quality of the water it is expected in large plants which run 24 hours that the current consumption will vary between 30 and 125 kw.hr. per million gallons, allow-

---

*By Max Von Recklinghausen, of the R. U. V. Company, Inc., New York.

1914 28[illegible]

ing for a large safety coefficient. The labor charges are negligible, as the apparatus only needs an occasional cleaning and starting of lamp. Apart from this the lamps have to be repaired from time to time. When the water is of variable physical quality one will have to establish the plant so that all the lamps will be running during the period of least transparent water and only some of them during the period of greatest transparency.

If reliance is placed on chemicals to disinfect water, we must work close to and sometimes even over the limit of the amount which will not make itself objectionable by producing taste and odor in the water. There is an increasing opposition to the use of chemicals for the purification of water supplies. In the ultraviolet rays we have a system where we may choose our safety coefficient as high as we like. We may overdose our sterilization as much as we want without creating any objectionable features in the water, like taste and odor. The waterworks engineer has therefore in this system a much more satisfactory weapon against pollution than he ever had before.

Representative City Planning Conference Held at Toronto

THE Sixth National Conference on City Planning, the first of its kind ever held in Canada, was opened on Monday, May 25, in Convocation Hall, Toronto University, by His Royal Highness the Duke of Connaught. The congress, which concluded on May 27, was one of the most successful on record and the delegates, representing 74 cities and towns of Canada and the United States, of whom upwards of three hundred were in attendance including a number from Great Britain, will carry away with them many practical lessons relating to the scientific and architectural sides of city planning and city development. Exhibits showing plans for the improvement of many cities on this continent and abroad, as well as of the work which has already been accomplished in giving effect to these proposals, were conveniently arranged in the hall at the rear of Convocation Hall, and added immeasurably to the interest and value of the conference.

The Duke of Connaught, addressing the conference, paid a tribute to Toronto in stating that the energy, good taste and public spirit of its citizens had resulted in the construction of a beautiful, spacious city. He looked upon city planning as among the most pressing of the many problems confronting the public men of our cities in Canada to-day. Having alluded to the evils that resulted in European countries from the haphazard construction and planning of houses and streets, His Royal Highness emphasized that with such lessons before us it would be nothing short of a national disaster if a similar state of things were allowed to develop in Canada. The problem was one which admitted of no delay. He concluded by emphasizing the need for providing ample park and playground space, the creation of main arteries of communication in cities, and the securing of adequate housing conditions for an increasing urban population.

Hon. Geo. McAneny, President of the Board of Aldermen, New York City, in thanking his Royal Highness on behalf of the conference, said that the city planner of to-day was working out the great problems that had to do with the betterment of the social conditions of the people in cities. He congratulated the Duke of Connaught on the part played by the British nation, the inspiration for the work on the American continent having come from England. Speaking of the wild growth of many cities, he instanced the case of New York where they were spending millions to-day on connections which might have been foreseen.

After the opening ceremony the members were entertained at luncheon in the School of Science building, Toronto University, by the Ontario government. The delegates were welcomed by Dr. J. W. S. McCullough, Provincial Officer of Health, and Mr. Nelson B. Lewis, Chief Engineer of the Board of Estimates and Apportionment, New York, suitably replied.

The business sessions of the convention were opened at 2.30 p.m., Hon. Geo. McAneny, President Board of Aldermen, New York City, presiding. The delegates were formally welcomed by Hon. Clifford Sifton, chairman of the Conservation Commission of Canada, who reviewed the growth of the city planning idea. Canada had paid little attention to the problem of building for the future, and it was only about three years ago that a general awakening had been witnessed and a practical effort made to cope with the conditions which had grown up through neglect. Various organizations had set themselves to the solution of the difficulty. The Toronto Harbor Board had an important scheme that no doubt would afford much relief in the future. He emphasized the necessity of a comprehensive town planning act for the Dominion. Rational city planning would do much to cure their present unsatisfactory conditions, and the real problem which faced the intellect of the twentieth century was whether we are big enough to grapple with present evils. Mr. Frederick L. Olmstead, chairman of the executive committee, replied, after which the greetings of the British Town Planning Institute were conveyed by Mr. Thos. Adams, London, Eng.

Mr. Robt. S. Gourlay, Toronto Harbor Commission, gave an address on "Basic Principles of Waterfront Development as Illustrated by the Plans of the Toronto Harbor Commissioners." He referred to the projected deep waterway scheme for Toronto and the proposal to reclaim the marsh lands and make them productive by turning them into factory sites. The paper gave rise to much discussion, taken part in by representatives of Harbor Commissions of Canada and the United States.

The evening session was opened at 8 p.m. with an address on "Certain Aspects of Municipal Financing and City Planning," by Mr. Andrew W. Crawford, of Philadelphia, who spoke upon certain aspects of the subject and laid down the principle that no municipality should issue bonds unless the object were reasonably adequate for the subsequent needs of the community.

The subject of "British Loans in Canada" was introduced by Mr. G. Trafford Hewitt, London, Eng., who alluded to the lack of control over municipal expenditure in Canada, and expressed the opinion that the Dominion required a board equivalent to the Local Government Board of Great Britain, to administer the municipal financial affairs in order that confidence might be re-established in Canadian investments. Hon. Geo. Langley, Minister of Municipal Affairs for Saskatchewan, pointed out that such a board was actually in existence in Saskatchewan.

Mr. G. T. Hewitt addressed the conference on "Canada as a Field for the Garden City Movement," describing the different types of garden cities in England, and lauding the enterprise in that direction which is being commenced in Nova Scotia, the first organization of its kind in Canada.

Tuesday's Sitting

The third conference session was opened at 10 a.m. on Tuesday in a paper delivered by Mr. Lawrence Veiller, Secretary and Director of the National Housing Association of New York, who declared that Canada was five years ahead of the United States in controlling residential districts and in the types of buildings erected in certain areas. The first step along this line was taken in the United States in 1909, when Los Angeles passed an ordinance prohibiting objectionable industries in certain parts of the city, but the movement had already been under way for five years in Canada, under the authority of the Ontario legislature. Those taking part in the discussion included Mr. Alfred Bettman, Cincinnatti, and Mr. Frank B. Williams, of New York. Mr. Williams said that in the administration of cities principles must as a general rule be applied, not to the construction of a new city but to the development of an old one.

The session concluded at noon and the members, having been photographed, journeyed to the waterfront, where they were entertained at luncheon by the Harbor Commissioners.

Canadian Town Planning

The evening session was resumed by Dr. Charles Hodgetts, Medical Advisor to the Conservation Commission of Canada, who presented the draft of a Canadian Town Planning Act for discussion. The draft bill provides that the act shall be administered under a Department of Municipal Affairs by a town-planning board consisting of a controller, who shall be the permanent paid executive official, skilled in town-planning, and chairman of the board. Every municipal authority is empowered under the act to erect a local housing and town-planning board, and to appoint a housing and town-planning commissioner who shall be the executive officer of the local board.

During an interesting discussion which followed, criticism was offered to the scheme, mainly on the ground of possible friction occurring between local boards and city councils.

Wednesday's Session

The concluding day was taken up with a discussion of rapid transit and transportation questions, initiated by Mr. J. V. Davies, consulting engineer, Brooklyn Rapid Transit Company, whose theme was "Provision for future rapid transit: subway, elevated or open cut, and their influence on city planning." The essential for rapid transit was the radial street running outward from the commercial centre, unless the traffic was placed underground. Comparing the costs of various systems of rapid transit, based upon the cost of trolley service in open country, he said that for every $25,000 spent on such a simple system the trolleys and streets cost twice as much; underground trolleys and streets twice to five times as much; elevated railroads, five times as much; open-cut railways, nine to ten times as much; masonry viaducts, twelve to thirteen times as much; subways in open country, sixteen times as much; subways in city streets, forty-seven times as much; and tube tunnels, one hundred times as much.

Mr. John A. McCollum, Assistant Engineer, Board of Estimate and Apportionment, New York City, said that the motor vehicle as a general transportation agent would surely be tried in this country. The two distinguishing characteristics of the motor 'bus advantage over other service transportation were—flexibility of movement, and flexibility of route. Mr. McAneny, New York, said that in New York they had added as a corrollary to the extension of their transit system the proper regulation of height of their buildings. Mr. Thos. Adams, London, Eng., an authority on town planning in Great Britain, said that transportation should be based on proper town planning. Mr. E. P. Goodrich, consulting engineer, New York City, expressed the opinion that the motor 'bus operated more rapidly than the trolley car, which was a material point in determining the kind of vehicle which should be operated.

The members of the conference were the guests of the city of Toronto at luncheon, a feature of which was three-minute talks by representatives of cities and city planning commissions of Canada and the United States.

At the afternoon session Mr. Henry V. Hubbard, Assistant Professor of Landscape Architecture, Harvard University, addressed the conference on the subject of playgrounds and recreation facilities in American cities. An interesting discussion followed, which was taken part in by Lt.-Col. Anderson, of Ottawa, Mr. Lawson, of Vancouver, and several others.

The appointment of the executive committee for 1914-15 took place in the afternoon, the members selected including the following: Dr. Chas. Hodgetts, Ottawa; Mr. J. P. Hynes, architect, Toronto; Mr. E. P. Goodrich, Consulting Engineer, Borough of Manhattan; Mr. Geo. S. Webster, Chief Engineer, Philadelphia; Mr. Edward H. Bennett, architect, Chicago; Mr. Geo. B. Ford, architect, New York City; and Mr. John Nolan, landscape architect, Cambridge, Mass. Messrs. S. Morley Wickett and A. J. Anderson, Toronto, are amongst those appointed on the General Committee.

Invitations for next year's conference were received from San Francisco, Cincinnatti, Baltimore, and Detroit, and the matter of selection was referred to the Executive Committee.

Proposed National Municipal Association of Canada

The Canadian delegates met on Wednesday afternoon to discuss the advisability of forming a National Municipal Association of Canada. The idea met with general approval and a resolution was adopted requesting the Commission of Conservation to create a special Bureau of City Planning as a central body, to co-operate with provincial or other housing or town-planning organizations.

The Conference closed with a dinner on Wednesday night, at which the members were the guests of the Conservation Commission.

A contract for the erection of the new telephone building in Medicine Hat has been awarded to Messrs. Hotson, Leader & Goode of that city. An automatic telephone system will be installed.

The Nature and Utility of Building and Ornamental Stones

IN the following pages we illustrate a number of noteworthy Toronto buildings which stand as a monument to the enduring qualities of natural stone. The article has been prepared in compliance with requests for such data made from time to time and the material is abstracted from a brochure issued recently by the Journeymen Stonecutters' Association. It is hoped that the notes, as abstracted, will be found to embody helpful suggestions.

INDIANA LIMESTONE

The prominence which Indiana stone has achieved is due to the possession of three ideal qualities in a building stone—light, beautiful color; great strength and endurance; and adaptability to ornamental forms at small expense. The ease with which it is quarried and the facility and certainty with which the hewers and carvers can work out designs upon it, reduce the cost of producing the stone and preparing it for the walls of a building to a very reasonable figure. Granite and marble begin to be costly while they are being taken out of the earth, and when they cone to the stone-cutter to be dressed their hardness and brittleness still further increase their cost. Brownstone and sandstone are produced with comparative cheapness, as they lie in the quarry in strata and are easily broken out; but they are hard, brittle and difficult to carve, and the cost of cutting and dressing them, while not so great as granite and marble, is still very high. Oolitic limestone, on the contrary, is not an expensive material at any point from production to setting in the walls. It therefore enables the architect to carry out the most artistic designs as well in modest dwellings as in more pretentious buildings, such as churches, office and public buildings, the element of excessive cost being eliminated without sacrificing anything that is proper for useful and enduring construction. These qualities have rendered the stone universally popular, and the peculiar light and cheerful gray of Indiana stone has therefore become a marked feature of the churches, residences, office buildings and large structures of American cities.

Household Science Building, Queen's Park, Toronto. Indiana limestone.

Resemblance to Portland Stone

Indiana stone has not had the benefit of many years' trial to test its endurance, although some of it was used as early as 1850, and is still unimpaired. But oolitic limestone has been thoroughly tested elsewhere. The other great deposit of this stone was found in Portland, England, and was used entirely in the construction of Westminster Abbey, St. Paul's Cathedral, the old city wall of London, and many churches and buildings erected in the time of Queen Anne. Indiana stone and the Portland stone are of the same geological age and quality and are almost identical in composition. Indiana stone is the superior, however, owing to the lesser quantity of oxide of iron and magnesia which it contains and its consequent gain in being more nearly a pure carbonate of lime—a purity rarely, if ever, surpassed, and scarcely equalled in the world. Its superiority is further increased by the fact that it is more than fifty per cent. less porous than the Portland stone, the ratio being 1 in 20 for the latter against 1 in 42 for Indiana stone. Each of these stones possesses the excellent quality of never cracking or scaling, due to the fact that they are pure limestones and are not affected by gases existing in the air.

GEOLOGICAL REPORTS

The following extracts from the reports of independent scientific men, give briefly some information in regard to the geological character of the stone:

Report of Prof. M. Thompson, State Geologist of Indiana

The rock is an element of the St. Louis group, showing itself in a massive, evenly bedded stratum of homogeneous limestone of a whitish gray color. Upon careful examination with the glass its grain seems to be infinitesimal shells and shell fragments, all bound together by a firm and even setting of lime carbonate. No art of man could construct a mass at once so firm, even and workable and at the same time so elastic and strong. The stone comes from the quarry soft, tough and easily cut. In a short time it hardens, so that it rings with a musical note (like that of a steel bar) when struck with a hammer. A bar four feet in length and two inches square may be bent so as to deflect greatly, and when released will spring back to a right line with the promptness and energy of highly tempered steel. Upon being broken, the stone parts with a smooth direct fracture, showing a surprising evenness and continuity of texture, with no trace whatever of laminations, seams or changes of structure.

Geologically, the oolitic limestone is very interesting and its existence is by no means a problem easy of solution. The more it is studied, however, the more it appears to be the result of calcareous sediment deposited at the bottom of a deep trough in an otherwise shallow sea. The shells of which the greater portion of the rock is composed are, as a rule, much smaller than the smallest ordinary pinhead; indeed, barely distinguishable under the most favorable circumstances by the unaided eye. These minute shells are cemented together with a cement composed of fine fragment dust of other shells, and an intermediate setting of pure lime carbonate, which renders the whole mass perfectly homogeneous, elastic and resonant.

Knox Church, Spadina Avenue, Toronto. Indiana limestone.

Report of Prof. John Collett, State Geologist of Indiana

By far the most beautiful and valuable stone for architectural purposes is the oolitic limestone. The supply is simply inexhaustible, as it lies in massive strata of from twenty to seventy feet thick over a large area.

These strata are homogeneous, equally strong in vertical, diagonal or horizontal sections. The stone comes from the quarry so soft as to be readily worked by saw, chisel or planing machine, while on exposure it hardens to a strength of from 10,000 to 12,000 pounds to the square inch—a strength amply sufficient to sustain the weight of the largest structure in the world. It is of almost unprecedented purity, containing an average over the magnesian limestones, as it is not affected by decay in an atmosphere charged with the gases of burning stone coal. In natural outcrop it presents bold, perpendicular faces to the elements, showing every scratch and mark, unaffected after the exposure of thousands of years, as no other stone or rock does.

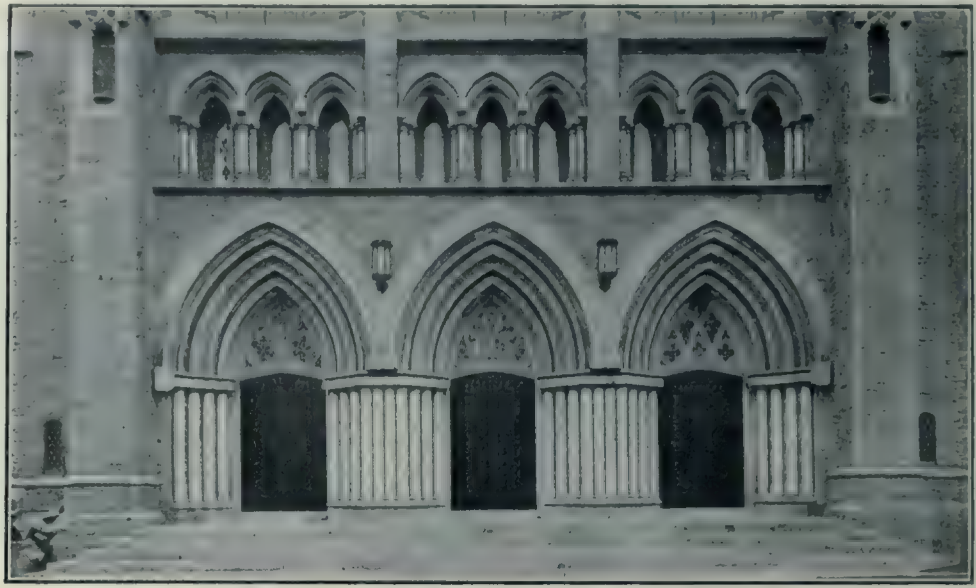
It is quarried by steam channelers, which carve it out in prisms of 6 x 10, 50 or 100 feet long, putting to shame the boasted prodigies of Egyptian story and effort. It is then rapidly sawed into blocks and dimension forms, and steam planers carve and mould it like clay or wood and more accurately than mallet and chisel. It is now fit to be carved into the finest kind of sculptured and ornamental forms.

Ready for the mason or sculptor, it is alive and resonant, answering with a clear metallic ring each touch or blow. This resonance is an excellent test of the perfect unity of its particles, and as a result it is highly elastic, bending under pressure and rebounding to place when relieved from it. This elasticity enables Indiana oolitic limestone to adapt itself without cleavage or disintegration to our changeable climate, where material will be frequently subject to a change of from twenty to sixty degrees of temperature in a few hours, as in large buildings the outside will be subject to a temperature of twenty-five degrees below zero in winter, or 120 degrees above in the summer, while the inside wall will remain at sixty or seventy degrees—a difference of fifty or eighty degrees in the extremities of the same stone—with their accompanying effects in expansion or contraction. The strains of heat and frost will tear down buildings and sides of mountains with their great expansive forces, and even steel and iron will give way before them. Here, then, is represented to the builder and architect a new and wonderful element in an elastic stone, a potent quality which when united with its other sterling excellences of strength and beauty, makes Indiana limestone the best in the world for exposed work in localities subject to great changes.

Crushing and Fire Tests

A test made by the United States Government gives the crushing strength of Indiana stone at about 135,000 pounds to the square foot. That this enables it to sustain an enormous weight is shown by the following table of maximum weights borne by the piers and ma-

Residence, Crescent Road, Toronto. Indiana limestone.



St. Paul's Church, Bloor Street East, Toronto. Indiana limestone.

sonry of well known structures: Piers of St. Peter's, Rome, 33,000 lbs. sq. ft.; piers of St. Paul's, London, 39,000 lbs. sq. ft.; piers of Brooklyn Bridge, 57,000 lbs. sq. ft.; granite masonry of Washington Monument, 45,000 lbs. sq. ft.; reliable sustaining weight Indiana Stone, 135,000 lbs. sq. ft.

Fire tests show conclusively that the oolitic stone is fireproof up to the point of calcination or turning into quicklime, in which respect it is superior to the average building stone, as far as shown by published tests. While a few building stones will withstand uninjured a temperature above the calcination point of lime, the greater number will be destroyed at a temperature below that point.

The Indiana Quarries Company, Indiana, recommend, in setting Indiana Stone, the use of a mortar made of one part lime and three parts sharp, clean sand, both for the stone and for the brick backing. It is not safe to use mortar for the stone and cement for the backing. Like granite and marble, Indiana stone is subject to stains from the penetrating acids in cement, and for that reason lime mortar should be used. These suggestions are based on the latest experience of builders who have used cement in connection with Indiana stone.

In the specifications for the city buildings in St. John's Park, New York, the architects, Messrs. Carrere & Hastings, instructed "All this material (Indiana stone) to be set in mortar of one part limeputty and three parts clean, sharp sand." Where the build-

Residence, Chestnut Park, Toronto. Indiana limestone.

Residence, Walmer Road, Toronto. Indiana Limestone.

ing laws do not compel the use of cement, it is believed that the most satisfactory method is to set both the stone and the brick backing in a mortar made in accordance with Carrere & Hastings' specifications given above.

Indiana stone is found in two colors—buff, or light gray, and blue. The buff is the more generally known and is produced in the greatest quantity. The blue comes from the bottom ledges and the amount in sight is always comparatively limited. It consequently takes a slightly higher price than the buff, but in all respects the two stones are of equal quality and texture. The "Hoosier light blue" is believed to be the most beautiful variety of the stone ever produced, fading on exposure to a soft, harmonious gray.

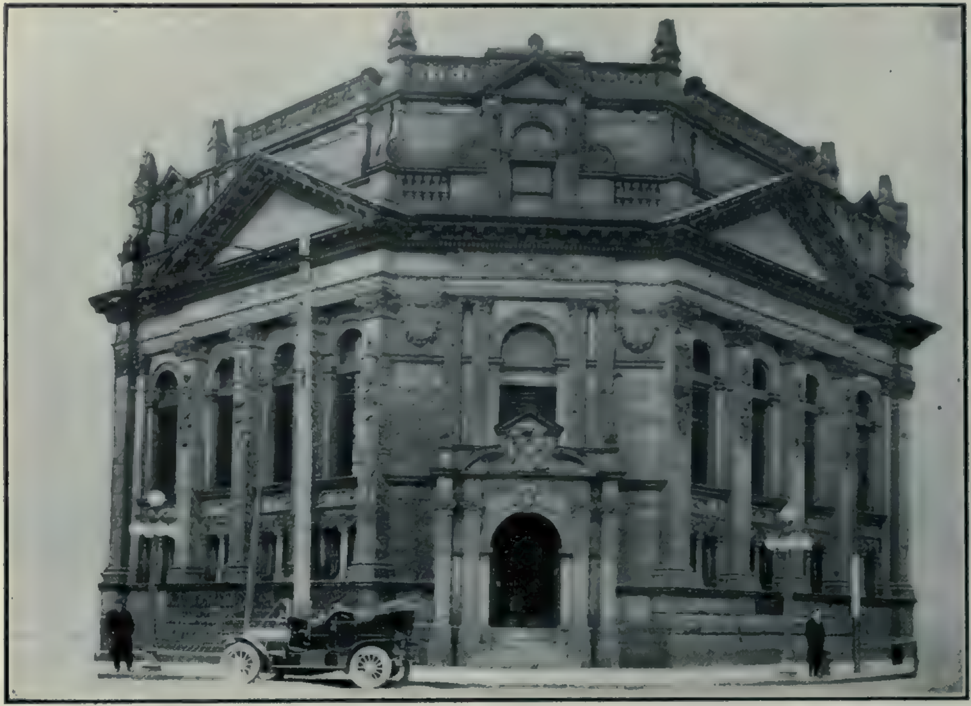
This particular stone lends itself admirably to the construction of public buildings, factories, warehouses and residences, and it can be obtained in any quantity and dimension. As well as being suitable for the purpose of expressing artistic design, it appeals to the business man because of its cheapness and durable construction.

OHIO SANDSTONE

The fitness of stone for structural purposes can be determined approximately by examining a fresh fracture. It should be bright, clean and sharp, without loose grains, and free from any dull, earthy appearance.

Tests of the strength of blocks of stone are useful only in comparing different stones, and give no idea of the strength of structures built of such stone, or of the crushing strength of stone in large masses on its natural bed. The crushing resistance per square inch of

Lieutenant-Governor's New Residence at Rosedale, Toronto. Ohio sandstone.



Bank of Montreal, Yonge and Front Streets, Toronto. Ohio sandstone.

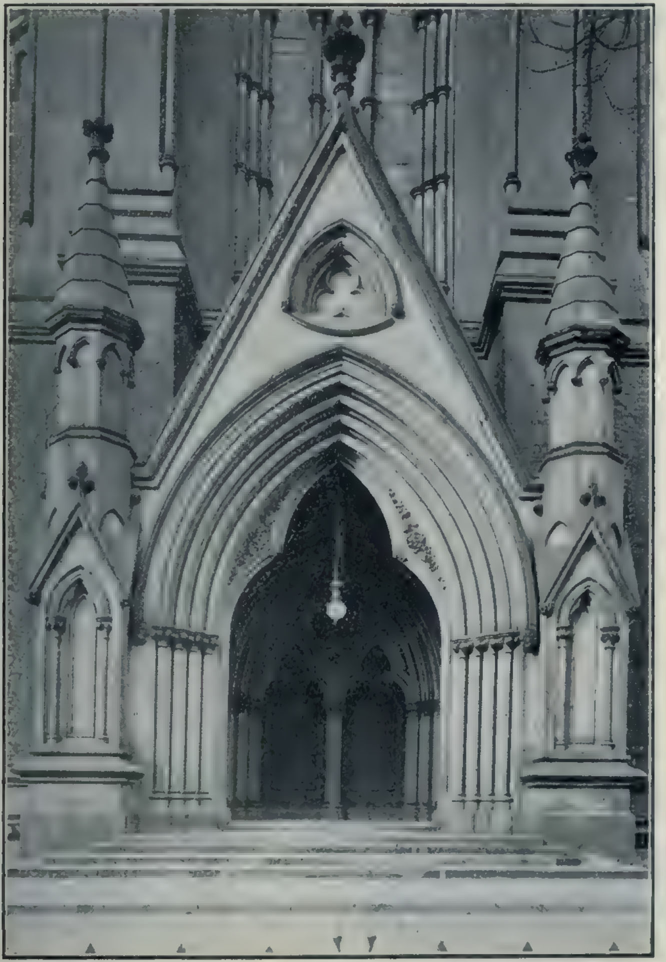
New Veterinary College, Toronto. Attractive use of Ohio sandstone.

The Nature and Utility of Building and Ornamental Stones

compressed surface increases approximately in the ratio of the cube roots of the sides of the respective cubes.

The durability of sandstone varies with both their physical and chemical composition. Great differences may exist in the durability of stones of the same kind, presenting little difference in appearance.

When nearly pure silica, and well cemented, sandstones are as resistant to weather as granite, and very much less affected by the action of fire. Taken as a whole, they may be regarded as among the most durable of building materials. When first taken from the quarry, being saturated with quarry water (a weak solution of silica), they are frequently very soft, but on exposure become harder by the precipitation of the soluble silica contained in them.


St. James' Cathedral, King Street East, Toronto. Ohio sandstone.

Doorway, Central Building, University of Toronto. Ohio sandstone.

The stone derived from the Gray "Canyon" and Berea quarries is a member of the lower carboniferous series, and is the most valuable geological formation in this country. It is homogeneous in texture and composed of nearly pure silica. These stones are a light blue-grey color, very resistant to fire and weathering, and, on the whole, are the best and handsomest building stones known.

Decoration and Utility

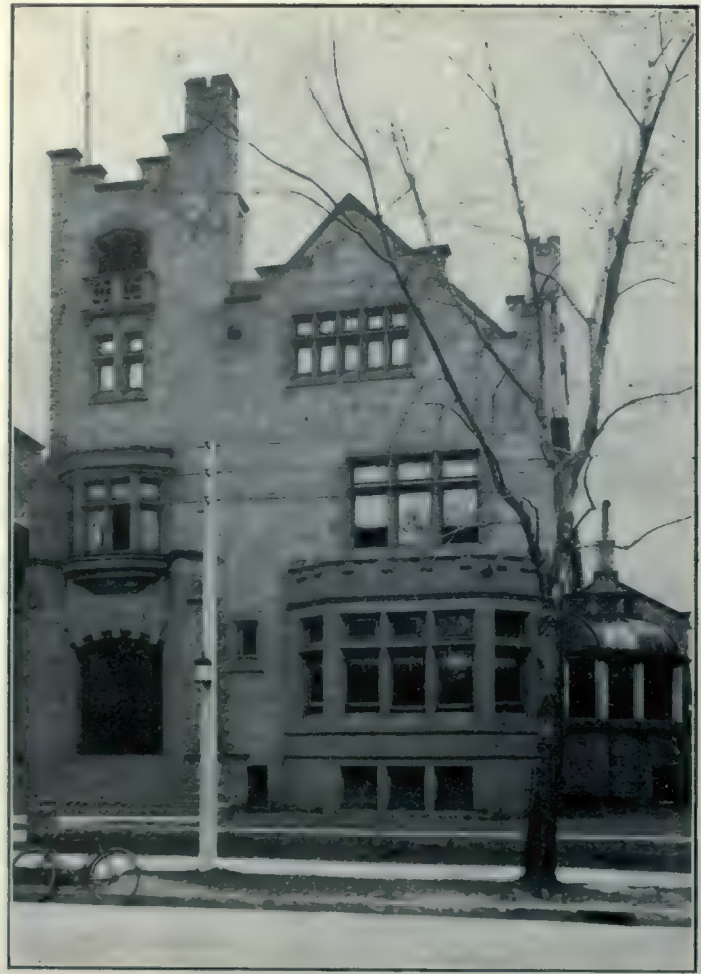
The utility and decorative value of the Ohio Sandstones has probably outrivalled any other sandstone as a suitable material for building construction. The firmness and homogeneous character of this stone render it exceedingly well adapted for ornamentation. The most elaborate design can be executed in the highest relief and retain its clean-cut outlines through generations of time and exposure. It is cheap and easily cut. As well as being adapted to distinctive art, it finds a customer in the residential builder, because of the uniformity of its strata and layers. These factors make it possible to split in any dimension with a minimum amount of labor, thus making it possible to construct at a very low estimate. It possesses a remarkable degree of elasticity, and is noted for the fineness of its texture, which enables the cutter to express in his workmanship both accuracy and precision.

This stone also possesses two distinctive colors, generally known as buff Amherst and Grey Canyon. These characteristics are considered very important by architects, as aiding them in design, "both for interior and exterior decoration."

CONNECTICUT BROWNSTONE

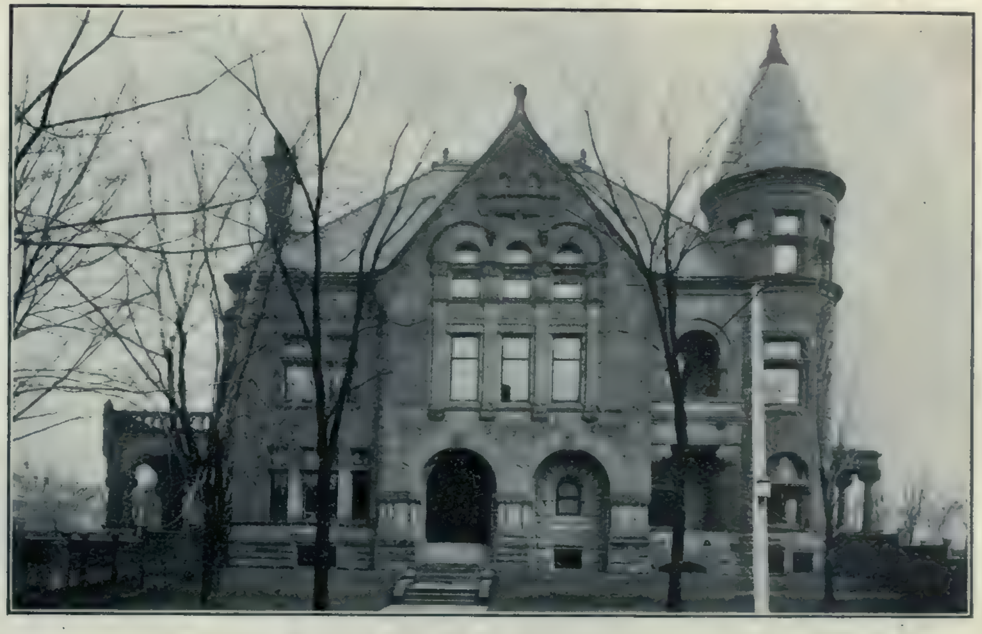
This stone is quarried at Portland, Connecticut, and has been used in the construction of many of the best buildings in the United States and Canada, both for general utility in buildings and for monumental works. Its color is a rich dark brown, not unlike those quarried in Nova Scotia and New Brunswick. It is absolutely free from clay, marl or gravel, which weather out on exposure to the atmosphere or cause fractures in working, and if laid upon its natural bed it is calculated to withstand the ravages of time and weather for many generations.

Many noted buildings in the States date so far back that they have become landmarks in history. In this particular mention might be made of the Connecticut

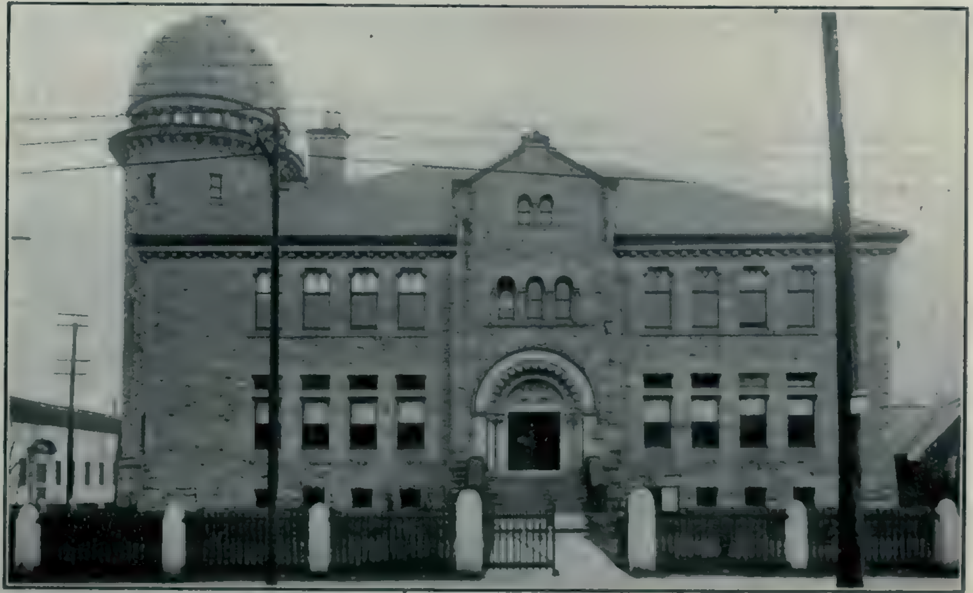


The Moose Club, Sherbourne Street, Toronto. Connecticut brownstone.

The Nature and Utility of Building and Ornamental Stones



Club House, St. George and Bloor Streets, Toronto. Portage sandstone.



Meteorological Observatory, Bloor Street West, Toronto. Miramichi sandstone.

Parliament Buildings, (North Entrance,) Toronto. Sackville sandstone.

State House at Hartford, which was built in the year 1794. Connecticut Brown Stone has stood not only the test of time and weather, but also of fire. The Flood residence, on Nob Hill, San Francisco, demonstrated during the earthquake, and the fire which followed, the remarkable power if this stone to resist the ravages of fire, in so far as it is still a remarkable building, and shows but little sign of deterioration.

PORTAGE BROWN SANDSTONE

The characteristics of Portage Sandstone are very similar to Connecticut stone, both in color and chemi-

Confederation Life Building, Richmond Street, Toronto.
Portage sandstone.

Toronto City Hall.
Sackville and Credit Valley sandstone.

Residence, Elm Avenue, Toronto. Sackville sandstone.

cal constitution. This is a stone possessing a very fine texture and depth of color. If the reader will take the trouble to examine the Yonge Street entrance to the Confederation Life Building (Toronto), and the twisted columns on Richmond Street, it will leave no room for doubt regarding the possibility of expressing therein artistic design. It fulfils the desired qualifications of beauty, strength and durability—the requisites of a good sound building material.

MIRAMICHI SANDSTONE

New Brunswick

The Miramichi Sandstone is unique in its formation, and the irregularity of its lines, combined with its buff color, invite the claim of its being select. It presents a very fine texture, thus suggesting the possibility of inscribing high and expressive art, is uniform in color, weathers well, and is not susceptible to discoloration. Its color is pleasing to the eye, and it maintains its clean-cut outlines through generations of time and exposure.

NEW BRUNSWICK BROWNSTONE

Sackville

The most noted and extensively used Sandstone of New Brunswick is known as "Sackville," the isolated formation of rock deposited at Sackville during the new red stone period, so graphically described by Dawson, the noted geologist, as being unique and very different from any other deposit in the province. The formation is in horizontal beds, from 2 feet to 9 feet thick, and is uniform both in color and quality, which renders it a very useful material for building and architectural designs. It blends with the color of brick, is

Residence, Deancroft, Glen Road, Toronto. New Brunswick sandstone.

strong and durable, as well as being one of the cheapest cutting stones on the market. During the past few years there has been a great expansion in this particular stone area.

ONTARIO SANDSTONES

Grey Medina Sandstone

Grey Medina sandstone, is the finest building stone at present produced from the sedimentary rocks of Ontario. While minor variations, such as greater or less development of "reed," slight difference in hardness, color and brilliancy, are to be noted, the general character of the grey Medina may be inferred from the following description. The general color of the stone is mottled grey. In places it is quite uniform, but fine horizontal lines, representing the bedding planes, may be observed in most of the stone, particularly after weathering for a short time. On treatment with carbonic acid in water, the color is not materially affected.

Confederation Life Building, Yonge Street, Toronto. Portage sandstone.

Under the microscope the quartz grains have an average diameter of less than one-eighth of a mm. There is, however, a large number of very fine grains scattered between the larger ones. Considerable feldspar in a partly decomposed condition is present, as well as several other minerals in very small amount. The cement, which is largely of a calcareous character, is quite evident, but interstitial pores are not to be seen with distinctness, despite the high percentage of pore space.

In response to a request, we herewith append a brief summary of the limestones of Ontario with information as to their physical capacity and chemical constitution.

Limestones of Southern Ontario

The province is rich in limestones of various kinds, some of them well adapted to building purposes, others particularly suited to heavy construction, and others which find a use in a great many ways outside the scope of this report. East of the Archaean axis, building stone is obtained from the Beekmantown, the Chazy, the Black River, and the Trenton formations. West of the axis the chief formations yielding good stone are the Black River, the Trenton, the Niagara, the Guelph, the Onondaga, and the Hamilton. The stone from each of these formations, while presenting many variations from place to place, is characterized by certain features which make its recognition comparatively easy. In the summaries appended to the descriptions of the different areas will be found a general statement as to the character of the stone.

St. Mary's Area—Onondaga Formation

The physical properties are as follows:—

Specific gravity	2.709
Weight per cubic foot, lbs.	167.513
Pore space, per cent.	0.92
Ratio of absorption, per cent.	0.34
Coefficient of saturation	.72
Crushing strength, lbs. per square inch	18242.
Crushing strength after freezing, lbs. per square inch	20194.
Loss on freezing, per cent.	0.015
Loss on treatment with carbonic acid, c.c. per square inch per hour	0.3221
Transverse strength, lbs. per square inch	3474.
Chiselling factor	5.5

No inclusion or large fossils detract from the value and it must be regarded as a very desirable stone.

An analysis from one of the upper beds is as follows:—

Water	0.14
Silica	2.32
Ferric oxide	0.88
Alumina	0.17
Calcium carbonate	94.24
Magnesium carbonate	2.19

Queenston Area—Niagara Formation

This limestone is distinctly bluish in color, but on weathering it looses the blue and assumes a pleasing grey.

Specific gravity	2.789
Weight per cubic foot, lbs.	162.015
Pore space, per cent	6.92
Ratio of absorption, per cent	2.67
Permeability, c.c. per square inch per hour	5.
Coefficient of saturation	0.32
Crushing strength, lbs. per square inch	18691.
Crushing strength after freezing, lbs. per square inch	12689.
Loss on freezing, per cent	0.092
Loss on treatment with carbonic acid, grams per square inch	0.0581
Transverse strength, lbs. per square inch	2361.
Chiselling factor	4.6

Analysis: H. A. Leverin, Mines Branch laboratory:

Insoluble matter	1.12
Ferrous oxide	.90
Ferric oxide and alumina	.60
Calcium carbonate	72.37
Magnesium carbonate	24.12
Sulphur	.064

Marmora Area—Trenton Formation

Specific gravity	2.723
Weight per cubic foot, lbs.	169.827
Pore space, per cent	0.066
Ratio of absorption, per cent	00.024

Crushing strength, lbs., per square inch, 37705 (the highest result for any stone referred to herein).

Most of the beds of this quarry produce a building stone of a hard and durable character in sizes convenient for handling. The marketable output varies from 5 to 14 inches in thickness and is practically inexhaustible. The stone splits easily along the bedding, and at right angles to that direction breaks with a clean fracture, so that rectangular blocks are easily prepared. For rock face work the stone is highly desirable, but as it is somewhat brittle and is possessed of a strong conchoidal fracture it does not chisel easily. Dressed work is liable to be marred by the flaking off of shell-like chips unless great care is taken in the operation.

Mountain Area—Peekmanton Formation

On weathering, the stone becomes still darker and assumes a minutely punctuate appearance. Treatment with carbonic acid produces the same effect, but not to such a marked degree. Microscopically, the stone is composed of a mass of small crystals of dolomite averaging about ¼ mm. in diameter. Scattered larger crystals are seen throughout the finer grained base. Open interspaces are very apparent; these seem to ramify and to run irregularly through the stone.

The physical properties are as follows:—

Specific gravity	2.836
Weight per cubic foot, lbs.	151.38
Porosity, per cent	12.607
Ratio of absorption, per cent	5.09
Coefficient of saturation	0.3
Permeability, c.c. per square inch per hour	13.12
Crushing strength, lbs. per square inch	15588.
Crushing strength after freezing, lbs. per square inch	13280.
Loss on freezing, per cent	0.081
Loss on treatment with carbonic acid, grams per square inch	0.01228
Transverse strength, lbs. per square inch	1130.
Chiselling factor	5.4

Chemical Analysis:—

Insoluble matter	1.08
Ferrous oxide	.76
Ferric oxide and alumina	.56
Calcium carbonate	55.53
Magnesium carbonate	42.14
Sulphur	0.29

Pembroke Area—Chasy Formation

In structure the stone is exceedingly fine grained and shows distinctly its composition of substances of different chemical nature.

The physical properties are as follows:—

Specific gravity	2.776
Weight per cubic foot, lbs.	171.628
Pore space, per cent	0.936
Ratio of absorption, per cent	0.340
Permeability—not determined	
Coefficient of saturation—not determined	
Crushing strength, lbs. per square inch	22706.
Crushing strength after freezing, lbs. per square inch	24500.
Loss on freezing, per cent	0.028
Loss on treatment with carbonic acid, grams per square inch	0.112
Transverse strength, lbs. per square inch	2441.
Chiselling factor	5.2

This stone is compact, fine grained and easily chiselled. It has a strong tendency to split along the stratification and to chip out under the chisel. The color and weathering qualities are not of high character, although the strength appears to increase under the freezing test.

The following analysis indicates the chemical character of the stone:—

Carbonate of lime	83.96
Carbonate of magnesia	9.29
Carbonate of iron	0.69
Insoluble	6.06

Longford Area—Black River Formation

On weathering, this stone becomes very white with fine dark lines.

Specific gravity	2.701
Weight per cubic foot, lbs.	167.85
Pore space, per cent	0.408
Ratio of absorption, per cent	0.152
Coefficient of saturation	0.95
Crushing strength, lbs. per square inch	25000.
Crushing strength after freezing, lbs. per square square inch	19723.
Loss on freezing, grams per square inch	0.0049
Loss on treatment with carbonic acid, grams per square inch	0.189
Transverse strength, lbs. per square inch	2324.
Chiselling factor (somewhat doubtful as the stone broke and shattered)	4.86

Miller gives the following analyses:—

	Bed Probably Corresponding to No. 152.	Top-rotten Bed.	Yellow Bed.
Lime	53.42	52.42	34.28
Magnesia	.72	.85	16.25
Carbonate dioxide	42.68	42.00	44.70
Ferric oxide	.62	.22	.54
Alumina	.....	.41	.72
Sulphur trioxide	.17	.30	.....
Alkalies	.05	.....	.....
Silica	.....	.....	.....
Insoluble residue	2.78	1.38	2.80
Loss on ignition	.....	1.79	.....
Water	.72	.....	.06
Sulphuric acid	.....	.....	.44

Galt Area—Guelph Formation

Specific gravity	2.837
Weight per cubic foot, lbs.	151.17
Pore space, per cent	14.62
Ratio of absorption, per cent	6.05
Permeability, c.c. per square inch per hour	155.1
Coefficient of saturation	0.48
Crushing strength, lbs. per square inch	10990.
Crushing strength after freezing, lbs. per square inch	9801.
Loss on freezing, per cent	0.232
Loss on treatment with carbonic acid, grams per square inch	0.0148
Transverse strength, lbs. per square inch	817.
Chiselling factor	6.8

It will be observed that this stone has a rather low crushing and transverse strength and a high porosity. The ease with which it may be carved is indicated by the high chiselling factor of 6.8.

Fossiliferous limestone is specially adapted for standing enormous strain, and has been extensively used for piers of bridges.

Proportioning Concrete Aggregate*

Diagrams for Obtaining Proportions of Cement, Sand and Crushed Rock or Gravel to Make a Maximum Density Concrete

DIAGRAM No. 1 is for determining the percentages by weight of different sized sand, crushed rock or gravel, so that an aggregate mixed according to these percentages will have the smallest per cent. of voids possible or, in other words, be of maximum density. These curves are based on the ellipse-tangent theory as explained by Taylor and Thompson.

The percentages of the various sized materials depend on the maximum size of crushed rock or gravel used and the mesh of the screens that represent the limiting sizes of the various parts of the aggregate.

The method of using this diagram is as follows:

First, when sand and only one class of gravel or broken stone are to be used.

Example:

Material.	Size.
Sand	Passes ¼-inch and remains on 0.
Gravel	Passes 3-inch and remains on ¼-inch.

Find where the "sieve opening," which is the division line between the maximum size of sand and the minimum size of gravel, intersects the proper "maximum size of rock" line. For the example given the ¼-inch sieve opening line intersects the 3-inch maximum size of rock line at A, Diagram No. 1. A horizontal line through the point A to B will give the per cent. by weight of sand required—34 per cent. in this case. 100 per cent. minus 34 per cent. equals 66 per cent., which is the per cent. by weight of gravel required.

A denser aggregate can be obtained by using more than two sizes of material, and, as a general rule, the more sizes of materials used the less the per cent. of voids in the aggregate. For this reason the following example is given.

Second, when sand and a medium and coarse gravel are used.

Example:

Material.	Size.
Sand	Passes 0.1-inch, remains on 0.
Medium gravel	Passes 1¼-inch, remains on 0.1-inch.
Coarse gravel	Passes 2½-inch, remains on 1¼-inch.

The 0.1-inch sieve size intersects the "maximum rock equals 2½-inch" curve at C, Diagram No. 1, and gives 27 per cent. of sand.

Where the 1¼-inch sieve line intersects the "maximum rock equals 2½-inch" curve at D gives 64 per cent. of sand and medium gravel. 64 per cent. minus 27 per cent. equals 37 per cent. This is the per cent. of medium sized gravel required. 100 per cent. minus 64 per cent. equals 36 per cent., the percentage of coarse gravel required.

Crushed rock can, of course, be used instead of gravel, the method of using the diagram being the same in either case.

Percentages by weight of more than three sizes of materials may be determined in the same manner. Using materials sifted from "run of the bank" gravel, voids as low as 14 per cent. have been obtained by the author by the above method.

After the proper per cents. of the various sized materials have been found, a mixture or aggregate is

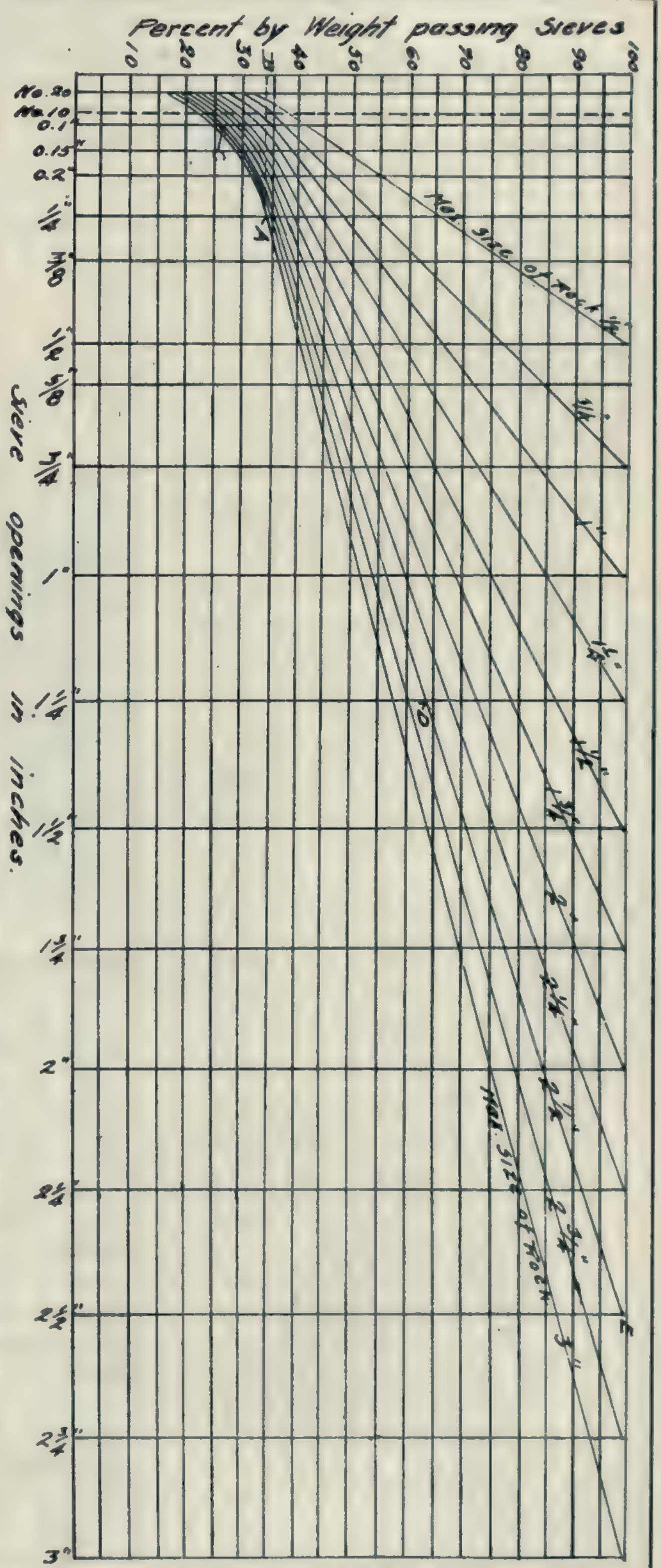


Diagram No. 1, for proportioning sizes of gravel or crushed rock and sand for maximum density.

---

* By F. C. Snow in The Municipal Journal.

made according to these percentages and the weight of a cubic foot of it is found by first compacting as much of the mixture as possible into a box that holds exactly one cubic foot, and then weighing this box full of aggregate, after which the weight of the box it subtracted, leaving the weight of a cubic foot of aggregate.

The specific gravity of the material in the aggregate is found by experiment or assumed from the table which follows, and with the weight per cubic foot and the specific gravity known the per cent. of voids in the gregate, after which the weight of the box is subtractstraight line on this diagram passes through the specific gravity, the weight per cubic foot and the per cent. of voids, as shown by the line ABC. At A the weight per cubic foot of the material is shown to be 130 pounds; at C the specific gravity is 2.66, and at B the per cent. of voids is found to be 22.

Table of Specific Gravities

Material.	Specific Gravity.
Sand	2.65
Gravel	2.65
Granite	2.7
Limestone	2.6
Trap	2.9
Slate	2.7
Sandstone	2.4
Cinders	1.5

The per cent. of cement to use is found by the following formula, which allows 2 per cent. excess of cement over enough to fill the void in the aggregate.

$$\frac{(\text{Per cent of voids plus 2 per cent.}) \times (\text{Weight of a cubic foot of cement})}{\text{Weight of a cubic foot of aggregate}}$$

or, if a cubic foot of cement weighs 96 pounds, the per cent. by weight of cement to use equals

$$\frac{96\ (\text{per cent. of voids in aggregate plus 2 per cent.})}{\text{Weights per cubic foot of aggregate}}$$

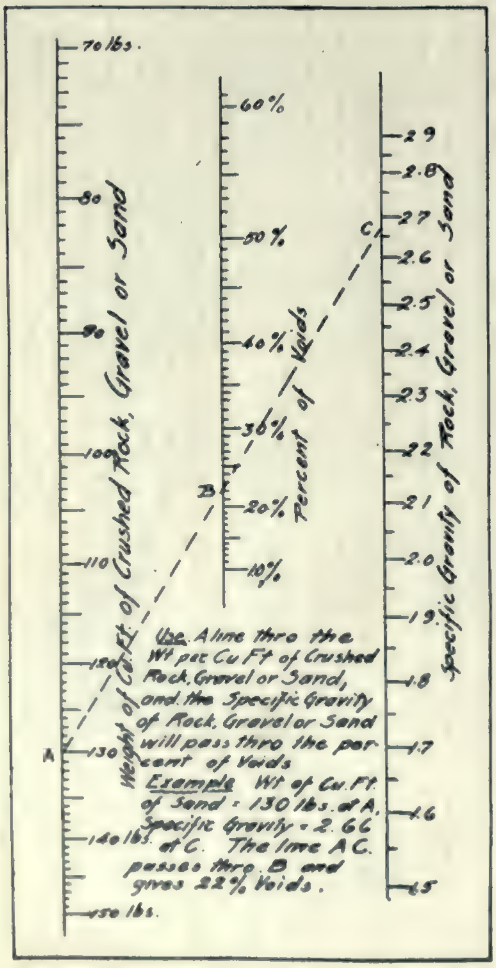
The proof of this formula is apparent.

Example: Weight per cubic foot of aggregate, 130 pounds; per cent. of voids in aggregate, 22; per cent. of cement required equals $\frac{96\,(22+2)}{130}$, equals 18 per cent.

If the aggregate in the two-size material problem given above weighed 130 pounds per cubic foot and had a specific gravity of 2.66, then the proper mixture by weight would be: 18 per cent. cement, 34 per cent. sand (0 to ¼-inch), 66 per cent. gravel (¼-inch to 3-inch), or 1 cement : 1.9 sand : 3.7 gravel.

It is usually the practice, however, to proportion

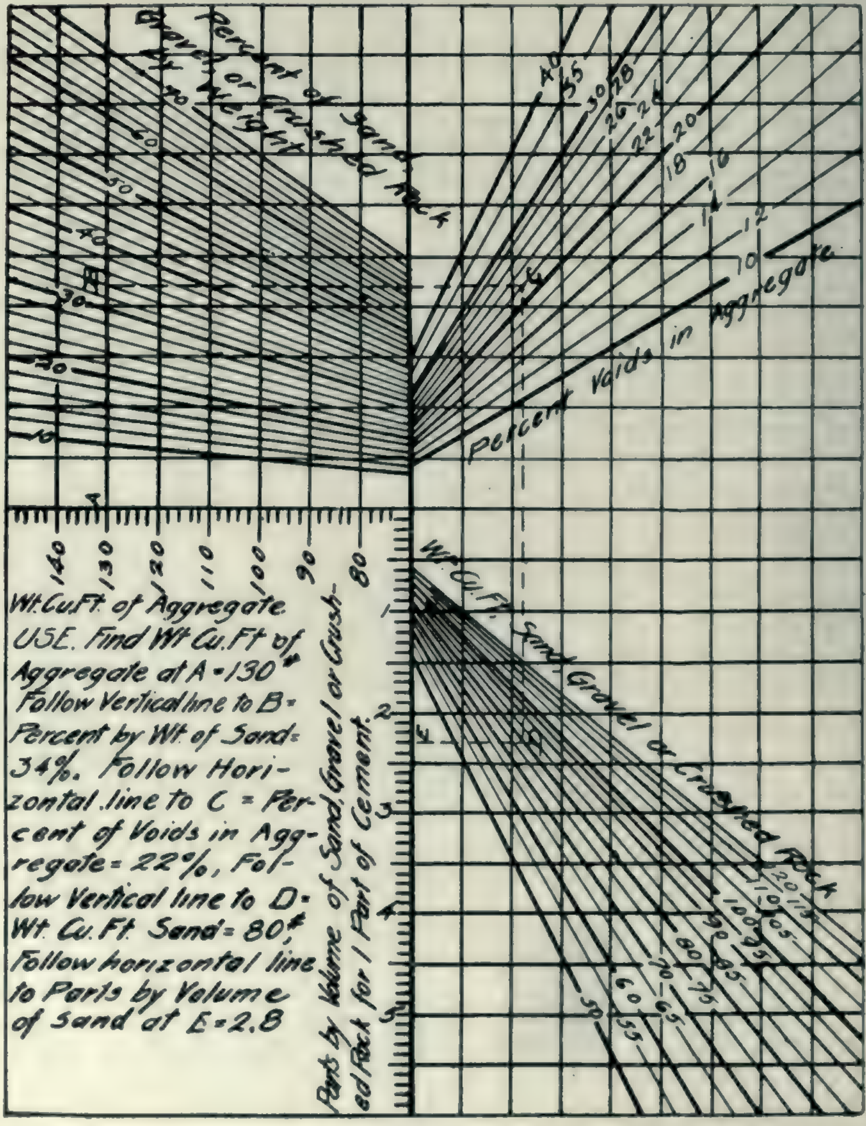
The smaller illustration, Diagram No. 2, is for percentage of voids in crushed rock, gravel or sand; the larger, Diagram No. 3, is for obtaining proportions by volume for concrete.



Use. A line thro the Wt per Cu Ft of Crushed Rock, Gravel or Sand, and the Specific Gravity of Rock, Gravel or Sand will pass thro the percent of Voids

Example Wt of Cu. Ft. of Sand = 130 lbs. at A. Specific Gravity = 2.66 at C. The line A C. passes thro. B and gives 22% Voids.

Diagram No. 2.


Percent of Sand, Gravel or Crushed Rock by Weight
70
60
50
40
30
20
10
A
B
C
D
E
35
30
28
26
24
22
20
18
16
14
12
10
Percent Voids in Aggregate
140
130
120
110
100
90
80
Wt. Cu. Ft. of Aggregate
Wt. Cu. Ft. Sand, Gravel or Crushed Rock
120 115
110 105
100 95
90 85
80 75
70 65
60 55
50
1
2
3
4
5
Parts by Volume of Sand, Gravel or Crushed Rock for 1 Part of Cement.

USE. Find Wt Cu. Ft of Aggregate at A = 130# Follow Vertical line to B = Percent by Wt. of Sand = 34%. Follow Horizontal line to C = Percent of Voids in Aggregate = 22%, Follow Vertical line to D = Wt. Cu. Ft. Sand = 80# Follow horizontal line to Parts by Volume of Sand at E = 2.8

Diagram No. 3.

Proportioning Concrete Aggregate

by volume and for the purpose of determining the proportions by volume Diagram No. 3 has been prepared.

It is necessary to obtain the weight per cubic foot of each class of material that goes into the aggregate in order to use this diagram, and this can be done by using the cubic foot box as explained above:

The use of Diagram No. 3 is as follows:

Find the weight of a cubic foot of the aggregate as at A (130 pounds). Follow a vertical line through this point to B, the per cent. by weight of sand is determined from Diagram No. 1 (34 per cent). Follow a horizontal line from B. to C, the per cent. of voids in the aggregate is found from Diagram No. 2 (22 per cent.). Follow a vertical line down to weight per cubic foot of sand, as at D (80 pounds). Follow a horizontal line through D to E, where the parts by volume for one part of cement are obtained (2.6).

The parts by volume of gravel are found in exactly the same manner, the proper percentage by weight and weight per cubic foot being used.

Example:

Material.	Size.	Wt. per cu. ft.	Per cent. by Wt.	
Sand	0 to 0.2″	103	39	From Dia. No. 1.
Medium Crushed Rock	0.2″ to ⅜″	100	15	
Course Crushed Rock	⅜″ to 1″	92	46	
Aggregate		139	100	

Specific gravity of aggregate, 2.65; per cent. of voids in aggregate from Diagram No. 2, 16. Proportions by volume from Diagram No. 3: Cement, 1; sand, 2.9; medium rock, 1.1; coarse rock, 3.8.

The formula on which Diagram No. 3 is based is:

$$\frac{1}{\text{weight per cubic foot of aggregate}} \text{ equals volume of aggregate;}$$

(volume of aggregate) x (per cent. of voids in aggregate plus 2 per cent.) equals volume of cement; or

(1 Volume of cement equals

$$\frac{\text{per cent. of voids in aggregate plus 2 per cent.}}{\text{weight per cubic foot of aggregate.}}$$

(2) Volume of sand equals

$$\frac{\text{(per cent. of sand by weight)}}{\text{weight per cubic foot of sand.}}$$

(3) Volume of crushed stone equals

$$\frac{\text{(per cent. of crushed stone)}}{\text{weight per cubic foot of crushed stone.}}$$

Dividing (1), (2) and (3) by 1:

Volume of cement equals 1.

Volume of sand equals

$$\frac{\text{(per cent. sand by weight) (weight per cubic foot of aggregate)}}{\text{(per cent. voids in aggregate plus 2) (weight per cubic foot of sand)}}$$

Volume of crushed stone equals

$$\frac{\text{(per cent. stone by weight) (weight per cubic foot of aggregate)}}{\text{(per cent. voids in aggregate plus 2 per cent.) (weight per cubic foot of stone)}}$$

These two equations are similar, and Diagram No. 3 is based on either one.

A bill vesting in the Board of Estimate and Apportionment the power to regulate the height of buildings has been signed by the Mayor of New York and now becomes law. Under the act the city will be divided into zones for the regulation of the height and character of new buildings.

Rapid Progress in the Electrical Field

In a paper read before the Royal Society of Canada, which held its meetings last week in Montreal, Professor L. A. Herdt, of McGill University, dealt with the tremendous developments in the electrical field which have taken place in the last ten years, due largely to the progress which electrical engineers have made in the economical transmission of electrical energy over long distances by tapping the innumerable rivers and streams flowing to the sea from the highlands. Practically every city or town in the province of Quebec, Ontario, Manitoba and British Columbia is furnished with light and power obtained by hydro-electricity. It was, continued Prof. Herdt, a good steam plant that was able to utilize 10 per cent. of the energy of the fuel, while the hydro-electric plant was capable of utilising as much as 70 per cent. of the energy of a waterfall. In the future, development of power transmission will no longer be restricted to the multiplication of local systems covering a few hundred miles, but will be in the direction of the construction of great plants placed at different points of a system extending its transmission and distribution lines over vast territories in the form of a single network. This will supply energy in the form of electricity for all our wants in the way of light, heat and power. Electric power and heat have a multitude of new services to render yet undreamed of, and will as years go by find a wide application for purposes at present but tentatively held out.

Supplies in Improved Demand at Montreal

There is a little better demand for builders' supplies at Montreal. Since the first of March the National Brick Company of Laprairie have been fairly busy, for although the large buildings in course of construction are very few, there is a considerable number of residences being built. The company have declared the regular quarterly dividend of 1½ per cent. Cement is being purchased more freely and other materials are in normal request. The demand for lumber is not up to expectations, and although stocks are low, there is no prospect of any substantial improvement. There is talk of trouble with the carpenters, who claim that they are entitled to a rise of 2½c an hour to 45c. The masters however stated that the agreement was conditional on the union enforcing the standard rate on all employers; this has not been done, and in consequence they decline to recognise the validity of the agreement.

A Substitute for Cement

In Turkey where cement is not used or hardly known, a substitute has been found that has met with rather good results when applied in exposed places, in filling crevices in water pipes, covering joints in stone floors, in fountains and for numerous other purposes where cement would be required. The mixture is as satisfactory in water as in exposed places, but it must be allowed to become thoroughly dry before it is submerged. The mixture is slaked lime, linseed oil and cotton fibre. Generally a hollowed-out stone is used, although a flat, hard surface will answer, and the process is started by pouring the oil on a handful of cotton, after which the lime is dusted in. It is then kneaded until the whole is thoroughly mixed and about the consistency of dough. The more it is kneaded the better it becomes.

Estimating the Cost of Earthwork and Concrete Construction

Specially Contributed by L. B. Merriam, M. Can. Soc. C. E.*

ESTIMATES of cost of large engineering works should be predicated upon knowledge of the conditions to be met, the amount of each class of work to be done, and the methods of construction best adapted to the conditions to be met. The work should be divided for estimate purposes into classes and each class should be divided again into units, each unit to cover all work where the same or similar methods and appliances are to be used. These units should be studied and a method of construction outlined. This method should be divided into its component parts and a basis of cost figured. While there are seldom two construction jobs alike, they are all accomplished by the same tools and machinery applied differently. This difference of application causes the cost of the unit of comparison to vary largely.

Sometimes you hear such a question as, "What is the price per cubic yard of concrete in this vicinity?" and if you answer, "From $5.50 to $25.00," it would probably be taken as a joke. But gravel concrete mixed one to eight where gravel can be handled directly from the car to the mixer and concrete from the mixer to the foundation trenches at small cost and where yardage in the trenches is large, concrete can easily be put in for $5.50 with cement at $2.00 per bbl. and gravel at $1.25 per cu. yd. On the other hand, where team haul is long on material, forming is complicated, quantity small per square foot of forming, with high grade concrete and special materials and surface treatment required, the work could easily cost $25.00 per cu. yd.

The cost of concrete, then, for any particular job varies with the conditions and requirements, and these varying requirements are paid for as material and labor. The materials used are cement, sand, gravel, crushed stone and lumber and hardware for forms. The labor may be performed either by hand or by machinery.

For convenience and accuracy, certain auxiliary items of labor and material are consolidated and various material and labor units are considered a part of them, thus:

The cost of cement consists of

1. Cost on cars at nearest available track.
2. Cost of handling from car to wagon.
3. Cost of hauling.
4. Cost of unloading.
5. Cost of storage shed.
6. Cost of packages lost or damaged.

The cost of sand consists of,

1. Cost on cars at nearest available siding.
2. Cost of handling from cars to wagons.
3. Cost of hauling.
4. Cost of unloading.
5. Cost of bins or other storage facilities.

In the same way the cost of gravel and crushed stone at the site of the work and ready for use may be analyzed. Lumber for forms must also be delivered on the work, with all mill and machine work performed, then the labor cost of erecting the forms is to be figured from experience in similar work. Where there is a duplication of forms, as in the construction of several piers of the same shape and size, the simplest method is to figure the cost of forming for one pier in detail and then by dividing by the number of cubic yards of concrete to be placed in that pier, obtain the cost per yard of concrete chargeable to forms. Where steel or other unit forms are used, or where lumber is to be used several times, then the total cost of material and labor used in connection with the forms must be divided by the total yardage to get the unit cost of forms.

Having thus found the unit cost of all material, the cost of 1-2-4 concrete can be tabulated as follows:

Cost of Concrete		Per Cu. Yd.
Forms, material and labor		$0.90
Cement, 1.57 barrels at $2.20		3.45
Sand, .44 cu. yds. at $1.40		.62
Stone, .88 cu. yds. at $1.80		1.58
Labor on cement, storage to mixer		.05
Labor on sand, storage to mixer		.22
Labor on stone, storage to mixer		.44
Mixer, rent of machine per day	$1.25	
Coal, 500 lb. per day	2.00	
Oil and waste	.25	
Engineer per day	4.00	
Loader and dumper	2.50	
Total per day	10.00	
At 100 cu. yds. per day		.10
Labor handling concrete to forms		.55
Foreman time keeper		.08
Actual field cost		$7.99

In addition to this cost there is the expense of getting plant on the ground, cost of bidding on several jobs in order to get one, insurance of workmen against accident, cost of surety bonds if any, and interest on the money used to purchase the materials in advance of their use and to meet the pay-roll and other expenses, and interest on deferred payments which are held back until the final estimate. These will be called overhead expenses and will be discussed later in detail. For the present case we will call this item five per cent. and the contractor's profit is taken as ten per cent., making the price of this cubic yard of concrete $9.20 for a contractor's bid, or $9.50 for an engineer's preliminary estimate.

The following quantities for materials per cubic yard of concrete for various quantities have been found very close to being correct and can be used in estimating costs and ordering material. Cement is figured in Canadian standard barrels of 350 lbs. net.

Mixture	Cement bbl.	Sand cu. yds.	Stone, cu. yds.
1-2-3	1.83	0.51	0.77
1-2-4	1.57	0.44	0.88
1-2½-5	1.29	0.45	0.91
1-3-5	1.22	0.51	0.86
1-3-6	1.10	0.46	0.93

Where good bank gravel is used without screening, one cubic yard of gravel and 1¼ barrels of cement will make a yard of concrete, but it is better to screen the sand from a cubic yard of gravel, measure this sand and put in cement enough to amount to 40 per cent. of the bulk of the sand, figuring 3.5 cubic feet as a barrel of cement. This, with good bank gravel, will make a concrete of the same class as the 1-3-5 mixture.

The study of concrete costs indicates that economies are possible in form design, in handling material from storage to the mixer and concrete from the mixer to the forms. Form design should be studied with an aim to reducing cost of forming and this feature in certain cases may set a pace for the work. When the work is delayed to permit the form material to be used more frequently, careful study of the effect of this delay on the overhead as well as other expenses should be made.

---

* Consulting Engineer, Winnipeg.

Material may be handled from storage to the mixer by wheelbarrows, man carts, horse and cart, track and dump cars or by conveyors of various kinds. Concrete may be handled by similar methods and also by elevating it and then conveying it to the forms by means of sheet iron chutes. This last method has proved to be very economical where applicable and properly installed. Narrow-gauge dump cars travelling on light steel rails and propelled by men, cables or electric locomotives are very efficient.

The point to be borne in mind is that the plant must be co-ordinated and should be designed in standard units so that as far as possible, all parts may be used on future work.

In making an estimate for any project, a complete schedule of the component parts should be made up and each part should be analyzed. In railroad work the general division of the component parts of the estimate are listed below:

Surveys
Clearing
Grading
Culverts
Ties
Track fastenings
Track laying
Ballast
Station buildings
Section houses
Watchman's houses
Engine houses and turntables
Water stations
Fencing
Stock yard
Crossinge, cattleguards, signs.
Dock and wharves
Grain elevators
Electric and gas plants
Construction equipment
General office expense
Engineering and accounting
Right-of-way
Grubbing
Tunnels
Bridges
Rails
Frogs and switches
Surfacing
Ballasting
Station furniture and equipment
Bunk houses
Tool houses
Shops and their equipment
Fuel stations
Snow fences and shed
Loading platforms
Interlocking and signalling
Transfer boats
Storage warehouses
Telegraph lines
General offices
Interest during construction
Provision for the maintenance of the road during the construction period.

Clearing right-of-way is estimated by the acre and is generally a comparatively small item on any job. Its cost varies widely with the character of the timber to be cut and the specifications as to the height of stumps and disposal of logs and brush. One man will cut about one-third of an acre of small sized timber of open growth a day. In large timber he will cut about one-tenth of an acre and the cost of piling and disposal of the brush is about the same as cutting, so the cost per acre of the clearing will vary from six days to twenty days' wages with proper allowances for foreman and overhead. The cost of grubbing out stumps and roots varies even more widely than the cost of clearing. The only method of estimating where the quantities are too small to warrant the installation of machinery, is from experience under similar conditions making allowance for any difference in labor conditions and cost. Where machinery is to be installed, a count of the stumps over an average area of, say, 100 feet square, will give close data for an estimate.

Grading may be further subdivided as follows:

Schedule 1.

WORK	CLASS	UNIT	METHOD
Grading	Ditching	Wasted	Man Work. 1. Drag Scraper.
		Hauled	2. Drag Scraper. 3. Wheel " 4. Fresno " 5. Elevating Grades.
	Borrow Teams		2. 3. 4. 5.
	Borrow Steam Shovel	Wagon Haul	6. Steam Shovel Traction Wheels Dump Wagons.
		Train Haul	7. Steam Shovel R. R. Wheels. Dinkies, Cars and Track.
	Excavation from Roadway Common Excavation	Wasted	2. 3. 4. 5. 6. 7.
		Placed in embankment	2. 3. 4. 5. 6. 7.
	Road Crossings		
	Excavation from Roadway Classified	Wasted	8. Drilling and Blasting. 9 Shovels and Wheeled. 10. Shovels and Carts.
		Placed in embankment	5. 6. 7. 3. 4.
		Overbreak	11. Handling.
	Overhaul	Teams	12. Wagons.
		Train	13. Cars and Track.

This general outline is simply an illustration of some of the numerous characteristic conditions and is used only as explanatory of and auxiliary to the following schedule for estimating the average cost of common excavation.

Schedule 2. Grading Schedule for Estimate.

Common Excavation

Station to Station	Unit method	Amount cu. yds.	Cost per cu. yd.	Total cost
0 — 45	2	13500	$0.114	$ 1,539.00
45 — 60	4	9000	0.106	954.00
60 — 83	3	15100	0.108	1,630.80
83 — 138	7	80000	0.182	14,560.00
		117600	$0.159	$18,683.80

The whole line should be gone over in the manner shown and each unit method number may appear many times and with a different cost placed opposite to it, as the conditions vary. At the same time the common excavation schedule is being made, one should also be made covering each class of classified material.

In rock work careful regard should be given to the specifications covering overbreak and their effect upon the cost.

Overhaul is commonly placed in estimates at 1c per cubic yard per 100 feet but this price is seldom proper and for team work is always too low to even pay the cost. Overhaul should be scheduled and an average cost figured.

Grading covers all earth work and rock work necessary to complete construction of a railroad except tunnels and the excavation for foundations of bridges and other structures below water level, although both these items are sometimes included in grading specifications. The profile furnishes all the information required with regard to the quantities of material to be handled and the conditions with regard to haul. These quantities and conditions are not always given in figures but can always be computed from the scale and roadbed and slope conditions given in the specifications. The first thing to do is to compute the quantities and separate them so that the quantities adapted for handling according to any one group method, as shown in Schedule 1, and separately totalled. During the inspection of the line the character of the material as to classification and ease of handling should be noted so that an estimate of the cost of handling each part of the work can be made as shown in Schedule 2.

The price attached to each piece of work will be the result of a decision with regard to the method of doing that particular piece of work and the character of the material to be handled, completing the data necessary for the compilation of a schedule along the lines of Schedule 2.

Most of our railroad grading is done by teams and as a precedent to any discussion of the methods of estimating the cost of work done by teams and as a basis for figuring such costs the per diem value or cost of a team of two horses and their driver must be determined. The best method is to estimate all work on the basis of the price at which teams can be hired in the vicinity of the work to be performed. Several other methods are used by different contractors, such as figuring cost, interest on the first cost and depreciation and dividing this sum by the number of days' work to find the cost per day per team then by adding the cost of the feed and care, get at the daily cost of an average team in the following manner:

Cost of team	$500.00
Interest for three years at 10 per cent. . .	150.00
	650.00
Value of team after three years	250.00
	$400.00

Three years' work at 200 days a year gives the cost of the team as 67c a day.

Loss of horses by death and injury brings this up and it is generally assumed at $1.00 per day or more.

An average horse, while working, will require about 20 lbs. of oats and 25 lbs. of hay per day. The quantity will depend largely on the quality, the best being the cheapest. Cost of feed varies with the location and conditions and should be figured for each job.

Teamsters are generally paid by the month with board and cost the contractor from $2.00 to $3.00 per day. So that the actual cost of teams including shoeing, harness, stables, medicine, care and feed in the vicinity of Winnipeg is something less than $5.00 per day, probably about $4.25. This does not include wagons, scrapers or other tools. Teams can be hired at $5.00 per day and this figure will be used as team wage in any examples of cost of work.

Slush scrapers or drag scrapers are applicable to grading work where the material is to be handled only short distances and not lifted to a height of more than five to eight feet, and should generally be restricted to the lower figure. The amount of material handled per team is large under proper conditions but drops off rapidly when conditions are not suitable. In good material with teams travelling 150 feet per trip a 14 team outfit will handle 900 cubic yards with drag scrapers at an expense as follows:

14 teams at $5.00	$70.00
4 scraper holders at $2.00	8.00
2 men trimming bank at $2.00	4.00
1 foreman at $5.00	5.00
1 blacksmith at $4.00	4.00
1 stable boss at $3.00	3.00
1 time keeper at $3.50	3.50
Rent of equipment	5.00
Cost of 900 cu. yds.	$102.50

Cost per cu. yd., 11.4c.

It will cost 5c per cubic yard for each additional 200 feet travel for the teams.

Wheel scraper work is capable of being used where the haul is longer and the lift higher than drag scrapers because the load is larger and the wheels make transportation easier. An eleven-team outfit with No. 3 wheel scrapers working in fair material with each team travelling about 300 feet each trip will handle 900 yards per day at an expense as follows:

11 teams at $5.00	$55.00
4 men loading at $2.00	8.00
2 dumpmen at $2.00	4.00
1 foreman	5.00
1 blacksmith	4.00
1 stable boss	3.00
1 timekeeper	3.50
Rent of equipment	6.50
Cost of 900 cu. yds.	$89.00

Cost per cu. yd., 10c.

It will cost 2c per cu. yd. for each additional 200 feet of travel for the teams.

Elevating grader work is divided into two parts which are separate and distinct, namely, excavating and loading, and hauling, which will be treated as one item and then separated to find the relative cost of each. The average output of this machine is 500 cubic yards per day when loading wagons. Six teams of horses are used to propel it and less men are used than would be required to furnish a teamster for each team. The cost of men and teams is, however, practically the same as the cost of six teams with teamsters. With 1½ cubic yard dump wagons the average load is about 1.1 cubic yards excavation measurement per load and about 450 wagons are loaded per day. Each wagon team loses one-half to two minutes following loading and turning out to start on his trip. The average for a five-hour trial was almost exactly 1 minute, making 450 minutes team time chargeable to loading in addition to the time of the teams employed on the machine, thus making the team time chargeable to loading each day 6.75 team days. The number of teams required to haul away this 500 cubic yards, assuming a rate of travel of 180 feet per minute and 500 foot haul with a loss of one-half minute each trip unloading and turning, is determined as follows:

		Team Days
450 trips with loss of ½ minute each		0.38
450 trips with loss of 1 minute loading		0.75
450 trips 1000 ft. each	$\frac{450,000}{180 \times 60 \times 10}$	4.17
Total		5.30

It will probably take six teams to do this hauling and the output will be increased slightly but not in proportion to the increase, let us say 525 yards output at the following cost:

12 teams at $5.00	$60.00
1 foreman	5.00
2 dumpmen at $2.00	4.00
1 timekeeper	3.50
1 stable boss	3.00
1 blacksmith	4.00
1 helper	2.50
Rent of equipment	6.00
Cost of 525 cu. yds.	$88.00

Cost per cu. yd., 16.8c.

Of this amount there is chargeable to:

Loading	$33.75	38.3%
Hauling	26.25	30.0%
Dumping and leveling	4.00	4.5%
Miscellaneous	24.00	27.2%
	$88.00	100.0%

As the miscellaneous expense is 27.2% of the whole, then by dividing the percentages of the other items by 0.728 and multiplying by 16.8 we have the cost, including everything, of loading 8.9c, hauling 6.9c, dumping and leveling

1c. The miscellaneous charge is large in this case as the gang is too small for economical operation and would ordinarily be about half the percentage shown. To find the cost of any increase or decrease in the length of haul per cubic yard per hundred feet figure the cost of the time of the team while travelling 200 feet and add the miscellaneous percentage and divide by the yardage hauled per load. In this case slightly over one cent per cubic yard per 100 feet.

The steam shovel is one of the most useful and widely used machines for handling earth and rock and is usually the best machine available for excavation of material which is to be transported for use at points distant from the point of excavation. The principles underlying its economical use are simple but are frequently not applied. A shovel which will load in a well organized gravel pit 1,500 cubic yards per day is frequently seen to average half that amount in an excavation where the material is just as easy to handle but where the track conditions with regard to loading cars are not systematized. The shovel output being held down by the fact of no cars being there to be loaded, this condition is very expensive and is brought about by the bad arrangement of tracks or shortage of engines and cars. There does not seem to be any adequate idea of the losses involved, otherwise they would be corrected. Where ever possible, trains should follow each other past the shovel in one direction only, making no reverse movements on the loading track. This conditions is seldom seen. The common condition is a passing track near the mouth of the cut where the loaded train passes the empty train and where the empty train must wait for the loaded train. The distance from the shovel to this track may be anywhere from two or three hundred feet to half a mile. Let us suppose for the purpose of this argument that this passing track is maintained at an average distance of 1,000 feet from the shovel and that the number of trains are ample to enable the empty train to always reach the passing track in time to meet the loaded one and be ready to start as soon as the loads are passed and see the amount of loss. Let us assume that these trains will travel at the rate of six miles an hour and that each train has eight cars of three cubic yards capacity each and that the shovel has an ordinary capacity for loading 1,500 cubic yards per day, including moving up, then it will load its train in 9.6 minutes and it takes the trains 4.6 minutes to make the run and get in position to load or so far as the shovel is concerned it can only load 24 yards in 13.2 minutes or at a rate of 1,090 yards per day. This shows a loss of capacity of over 27 per cent. and an increase in unit cost of the work 37.5 per cent. This is a big leak. They will say that the shovel moves up while the switching is being done, so saving a part at least of this time but experience has shown that where this is attempted more time is lost than in moving at the proper time to move in order to get the greatest efficiency from the shovel. At best the shovel should only move once while loading two or three trains where the average face is eight or nine feet. The time required to move the shovel back to start a new cut is lost and should be as short as possible. With a standard gauge hauling outfit, this time should be very short, ordinarily not exceeding two hours when a track is laid in the pit along the line of the new loading track closely following the shovel, which makes a continuous track for the shovel to move back on. It frequently pays to lay a three-rail loading track behind the shovel where narrow gauge loading outfit is used so as to have a standard gauge track to move the shovel back on. The time saved in moving back is generally costing from $10 to $15 per hour and the saving in actual money is greater than the difference in cost between this method and ordinary and slower methods.

Trains enough should always be provided to keep the shovel at work up to its capacity. With a narrow gauge hauling outfit, even on short hauls, at least two trains should always be used. Assuming as above, a train can be loaded in 9.6 minutes and the speed of the train is six miles an hour or 528 feet per minute and the time required to unload the train is three minutes, then with two trains, the total running time of the train, after deducting the time required to unload will be 6.2 minutes and the longest total travel a train can make and be at the shovel in time will be 6.6 x 528 = 3480 feet. When the distance travelled is longer than this, three trains will need to be put on. By the same reasoning, four trains will be required when the total travel distance of the complete round trip becomes 8,550 feet and an additional train for each increase of total travel of 5,000 feet. In case this schedule is used passing tracks must be placed at proper points and be moved from time to time as the shovel moves. A diagram similar to that used in making time tables on a railroad is an easy way to determine the location of these sidings. Fig. 1 shows the method.

In this figure, horizontal lines are spaced two minutes apart and each fifth one is made heavier and the figures given to show the time represented. The vertical lines are spaced 1,000 feet apart, the one marked 0 being at the shovel. It is assumed that it takes fifteen minutes to load a train and three minutes to unload. The first train in the morning is No. 1, the second No. 2 and the third No. 3. The trains all move past the shovel in one direction only and in order to do this the empty track joins the loading track 500 feet ahead of the shovel. The solid inclined lines show the trains moving at six miles per hour out to the dump 4,900 feet, stopping there three minutes, then going back at six miles per hour 2,400 feet to a piece of 3 per cent. grade 1,200 feet long, a speed of five miles per hour is assumed here, then at six miles per hour for 1,800 feet to the junction with the loading track 500 feet ahead of the shovel, then back to near the shovel at the same speed where a wait is made of about six minutes for the shovel to complete loading the previous train No. 3. The dotted line shows that if No. 1 was

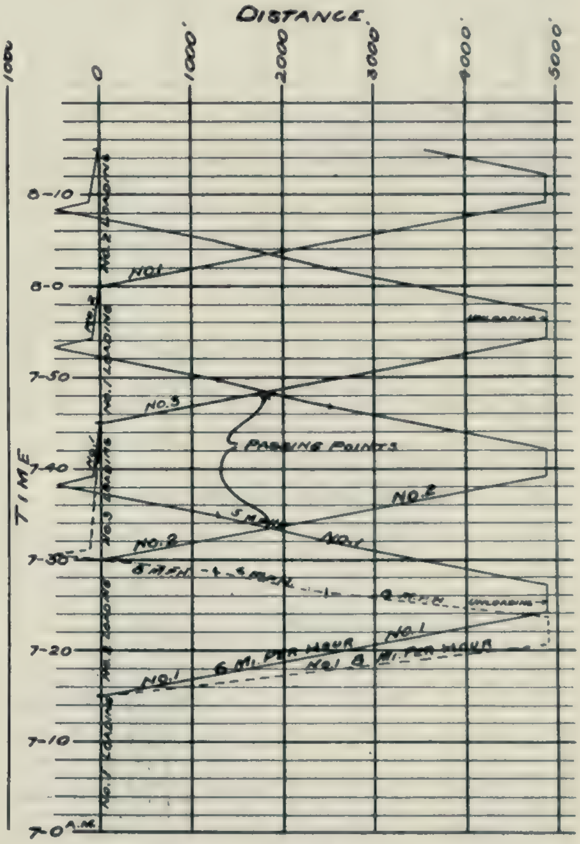


Fig. 1.

run at eight miles per hour over the favorable grades and six miles per hour over the unfavorable ones, that it would arrive at the shovel only about one minute too late to start loading as soon as the shovel finished loading No. 2. This minute of lost time would decrease the output about 80 cubic yards per day. A speed of over 10 miles per hour would be required to bring No. 1 to the shovel in time to start loading as soon as No. 2 was loaded and this is too fast time to figure on.

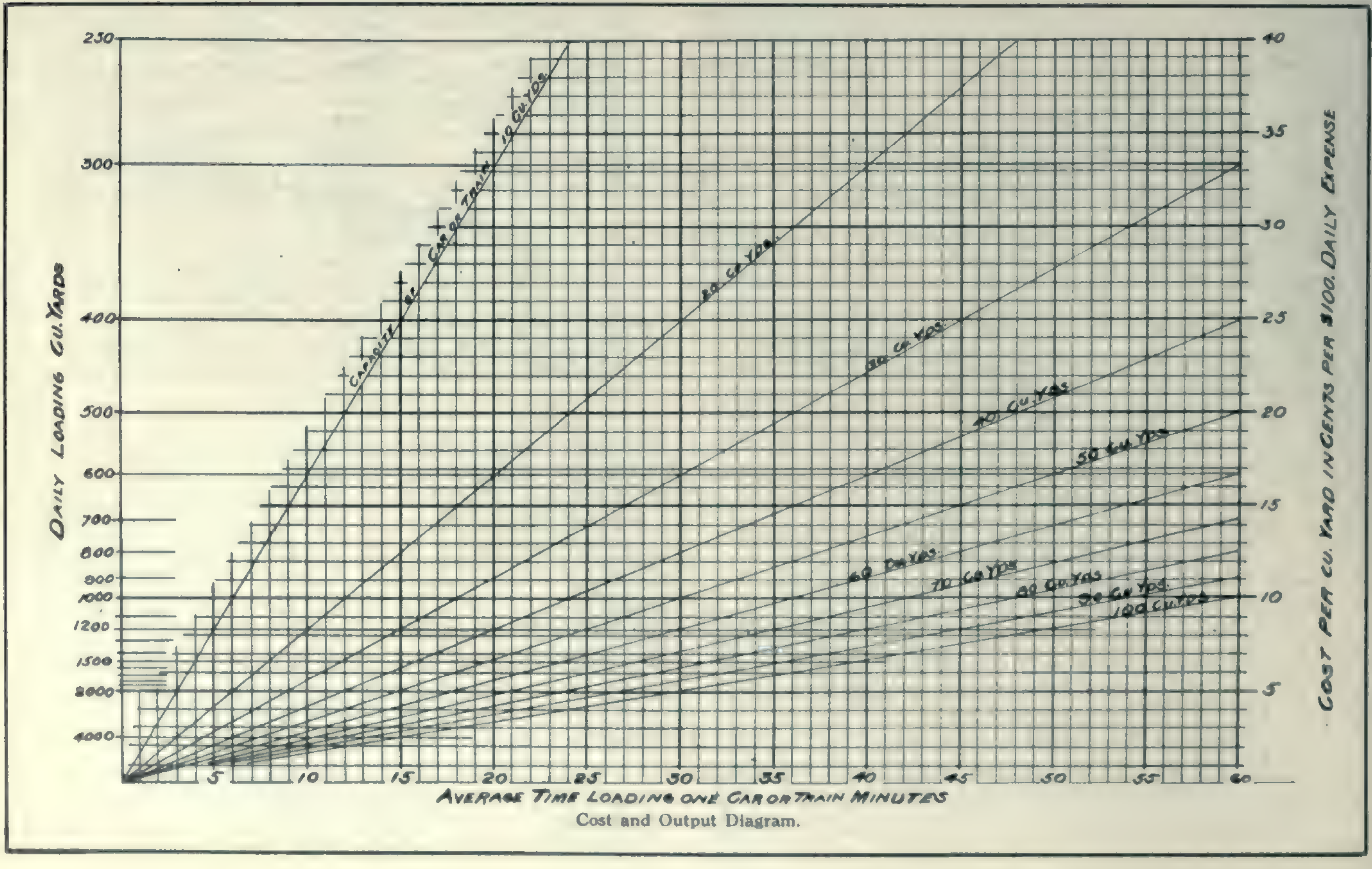
It is generally better to make some allowance for delays and put on more trains than the schedule calls for where the tracks are poor. If the conditions are such that the track can be maintained in good condition and grades are light, a higher speed can be assumed and a less number of trains. It is best to keep close watch on the conditions, using a watch to take the time required to load a train and see that there are trains enough to meet the conditions. The fact that cars are always there to be loaded keeps up the enthusiasm of the shovel crew. All the above is predicated upon having a shovel crew which knows how and is willing to get the best out of the machine.

The cost and output diagram is very handy in determining what is the best thing to do in regard to trains, their number and cost.

The vertical lines on this diagram are spaced one minute apart, every fifth one being made heavier and marked 5-10-15, etc. They give time required to load one unit. On the right of the diagram the horizontal lines are spaced one cent. apart, the even five being made heavier and marked. They represent the cost per cubic yard in cents for each $100 daily expenditure. On the left of the diagram, the horizontal lines are spaced to show the quantity loaded daily in cubic yards. The diagonal lines are drawn to represent the number of cubic yards loaded in each unit in any given number of minutes at the cost shown on the right and the number of yards per day shown on the left. These lines are drawn for each 10 cubic yards from 10 to 100. To find any intermediate quantities, interpolate along the horizontal lines and draw lines through the origin. It will be noticed that along the horizontal line representing the 600 cubic yards per day output, there are ten even spaces between each of the diagonal lines making it easy to make any interpolation above this line. Below it the 1200 cubic yard line has five spaces between the diagonal lines. To use this diagram, suppose we have 20 cubic yard trains and the average time it takes to load a train is 9 minutes and the daily expense is $95. Along the bottom of the diagram find the vertical line from 9 and follow it up to the 20 cubic yard line. It intersects this 20 cubic yard line at 7.5 cents on the right hand scale and 1,330 cubic yard on the left hand scale, the amount loaded is 1,330 cubic yards per day and the cost is $\frac{7.5 \times 95}{100} =$ 7.1 cents per cubic yard.

Fig. 2 shows the profile and layout of a cut of 150,000 cubic yards, with overhaul figured only on material placed in embankments amounting to 1,200,000 cubic yards overhauled 100 feet. There is also an item of 37,400 cubic yards which, according to the specifications is to be paid for as borrow, which can be hauled from the cut. It is figured that 25 to 30 per cent. of the cut will be classified as loose rock but will require no blasting and there will be 40,000 cubic yards of waste upon which no haul will be paid. It is required to figure the cost of doing the work. In order to do this we will lay out the work and figure the work according to Fig. 2. We will figure that a part of the cut at "A" will be taken out wide enough to lay a double track, narrow gauge railway on the grade "B-C" about 3 per cent. grade and a fill made at "D" on a 4 per cent. grade far enough out from the center line of the railway that the outside track will not be disturbed during construction and will be used as an empty train track and be extended and connected with the loading track after each cut is made.

The first steam shovel cut will be on the grade "D-E,"



Cost and Output Diagram.

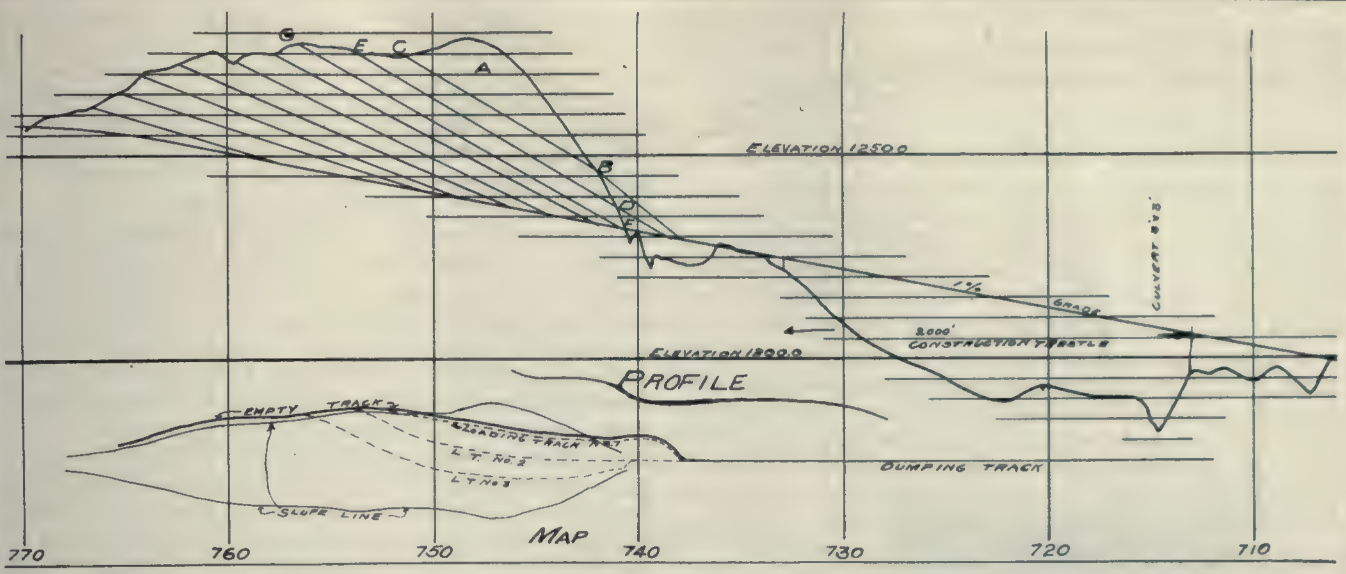


Fig. 2.

the second on the grade "F-G," each cut being taken on the next lower grade line as shown. The material at "A" will be taken out by the use of an elevating grader and wagons and will cost 15c per cubic yard. 12,000 yards will be removed but only 10,000 will be taken from the roadway section and paid for. This leaves 140,000 cubic yards for the shovel to move. A shovel of the size to be used on this work should handle 800 cubic yards per day and will take 175 working days to do the digging. It will move back eight times, say four days lost time. As there are 40,000 cubic yards of hard material, this will delay the shovel by cutting its capacity down to about 600 yards per day while in this material, adding 15 more working days and allowing 15 per cent. for bad weather and repairs and other delays, the shovel will be in the pit about 226 days. Moving the shovel onto the job is very difficult and will cost $1,200 and take ten days so the rent of the shovel should be for 236 days and the cost of the excavation would be as follows:

Shovel Expense

Moving shovel onto job	$1,200.00
236 days shovel rent at $8.00	1,888.00
226 days' work with shovel, including foreman, men, coal, oil, etc., at $35.00	7,910.00
Shovel expense	$10,998.00

As the price of loose rock is generally about twice the price of earth, we will call the yardage for the purpose of figuring unit cost 180,000 cu. yds., making the cost per cubic yard 6.1c.

In addition to shovel work the payment for the excavation includes 500 feet free haul on all material and dumping the same as well as trimming and completing the embankments and preparatory work. The cost of this preparatory work and dumping is as follows:

2,000 feet of trestles at $1.50	$3,000.00
8 men 226 days at $2.00	3,616.00
1 foreman 226 days at $3.50	791.00
12,000 cu. yds. moved by grader	1,800.00
Cost	$9,207.00

Cost of preparatory work and dumping per cu. yd. of excavation 6.6c.

Study of the haul shows that three trains will be needed for the longest haul and as they will be in use most of the time, three trains will be charged out in this example as great accuracy in the resulting cost is not intended but as an illustration of methods. The cost of hauling is found thus:

3 trains for 226 days at $14.00 each	$9,294.00
10 men on the track 226 days at $2.00	4,520.00
1 foreman on track 226 days at $3.00	688.00
Getting plant on the ground	700.00
Rent of track and cost of ties and spikes	1,200.00
Total cost of haul	$15,402.00

	cu. yds. 100 ft.
Pay for overhaul as above amounts to	1,200,000
Free haul 140,000 by 500 feet	700,000
Haul paid for as borrow 37,400 by 22	823,000
Total amount of haul to be paid for	2,723,000

Dividing the total cost of haul by its total amount gives the cost of haul per cu. yd. per 100 ft.	0.6c
A fair contract price	0.7c

To Assemble

The cost of free haul included in excavation charge.	3.0c
Shovel cost	6.1c
Preparatory and dumping cost	6.6c
Total cost of earth work	15.7c
A fair contract price would be	18.0c

And the 37,400 cu. yds. which was figured as hauled beyond the required limit and for which the payment would be made as if borrowed cost 22 x 0.6 = 13.2c per cu. yd.

The cost of loose rock excavation will be:

Shovel cost x 2	12.2c
Preparatory and dumping cost	6.6c
Hauling cost plus 10 per cent. account of swell	3.3c
Total cost of loose rock	22.1c
Fair contract price	24.0c

The loose rock cost is figured in a somewhat arbitrary manner as the data are usually incomplete. The location of loose rock in the cut is unknown and its very existence is unknown until it is encountered.

The other various items are to be taken up in detail in the same way and the prices worked out, the whole to be tabulated as shown and an average cubic yard price worked out to cover each classification of the grading estimate.

All other kinds of work must be taken up in the same way to arrive at estimating prices.

The haul on material required for the various parts of railroad construction is an item which is more apt to be neglected than any other whether the haul is made before track is laid, during track laying or after it has been laid. For instance, take the material used in the track; if the line is 100 miles long and all track material is delivered at one end of the line, the average haul on this material is fifty miles. The aggregate weight of material with 60 lb. rails and an allowance of 10 per cent. for spurs and sidings is 30,600 tons and the ton mile haul is 1,530,000 ton miles, this will cost at least 0.6c per ton mile making a charge at this rate of $9,200 against the item of track laying or nearly $100 per mile and as the length of line increases the train haul on material of all kinds becomes more important.

A mistake made by many engineers and contractors is the neglect of the item of plant rental or depreciation, or the minimizing or misunderstanding of this item. It would take but little work in accounting to get close figures on plant rental and depreciation. By plant is meant all machinery and appliances which, from their character, are expected to last longer than one season and which are more or less general in their use. These should be charged to a special account when purchased and each job on which they are used should be charged a per diem rental for their use. In estimating on any job, plant rental should be estimated the same as any other item. Special machinery which is bought or built for special jobs andwhich is not applicable for other use should be charged out to this particular job. Hand tools should be charged out to the job for which they are purchased and an allowance for them should be included in every estimate. They should be charged in each case to a special account so that when the job is completed their cost can be ascertained. In the plant account, each item of plant should be numbered and all heavy repairs charged to it and all plant rental credited. Ordinary repairs made by the blacksmith or machinist on the job should not be charged against the plant account but all purchases of repair parts should appear in the plant account.

In the absence of special knowledge of the depreciation of each item of plant which would be derived from a plant account, a good rule for figuring plant rental for any particular job is to charge 5 per cent. of the new cost of each item of plant per month to the job. This seems to indicate that the anticipated life of the item in question would be 20 months of actual service which is rather short for most items but it means in actual practice about five seasons' work when annual overhauling, repair parts and winter storage costs are taken into consideration. This is close to the actual fact as annual overhauling costs increase with the age of the unit and if the machine is to be kept in thoroughly efficient condition, these costs will accumulate and keep pace with the rental charge.

Overhead charges are of two classes: General and Job. The general overhead charges consist of office expenses of the general office, bidding costs and other items of similar nature relative to the general office, and may be figured on the basis of all work done by the contracting company and added to the job overhead.

Job overhead consists of interest on money required to meet payrolls and pay for materials bought and stored for use on the work, cost of bonds required by the contract, cost of liability, insurance, cost of job office, and salary and expenses of walking boss, superintendent, and all general utility men employed for the job as a whole. It should not however, include the wages of men employed in the general commissary store or any expense in connection with the store, as the profit on the goods sold should cover this item. Job overhead should also include cost of construction of roads and trails, cost of freight on equipment to the nearest point to the work reached by a common carrier and cost of headquarters camp buildings so far as they are to be used for the general administration of the job, also the cost of general storage yards or buildings for the storage of material for the job where the same are not for special use and capable of being distributed directly to any item of the work. These items should be kept as low as possible by charging out all expenses possible to the proper item of the work and should be estimated as a lump sum and reduced to a percentage of the cost of the job. This job percentage together with general percentage completes overhead charges. Having arrived at the overhead percentage of the cost of the work as above, this percentage should be added to the cost of each item to get its total cost. This cost plus a percentage for contractor's profit gives a bidding price or cost to the owners.

While a railroad has been taken as a basis of this article, the aim has been simply to illustrate the method of figuring basing prices fitting the actual conditions rather than guessing at them, although the latter is by far the most general way. The unit cost of projects of similar nature but in different locations will be different on account of differing labor conditions, hauling roads, frieght rates and other surrounding conditions. There is no way to find out how much difference these conditions should make in costs except by using the conditions in detail estimates in the general manner illustrated in this article.

At Winnipeg the contract to erect a new warehouse for the Ames-Holden-McCready Company has been let to the Lyall, Mitchell Company, at about $100,000. The building will be six storeys high, of mill construction, brick and stone. The architect is Mr. J. D. Atchison.

A quarry of variegated marble is reported to have been discovered on the south fork of Kaslo Creek, B.C. The material is said to be suitable for mantlepieces and statuary, also for ornamental stock such as tiling, wainscotting, brackets, etc. About $300,000 have been invested in plant and machinery.

Messrs. William C. Edes and Thomas Riggs, Jr., and Lieut. F. C. Mears, were appointed recently by President Wilson members of the Alaskan Railroad Commission, which will have charge of the location of railways to be built in Alaska under the act appropriating $40,000,000 for that purpose.

At Cornwall, Ont., the Glengarry Construction Company, Montreal, has received the general contract for the construction of the entire St. Polycarp Junction-Cornwall line of the Glengarry & Stormont Railroad. The work will include 275,000 cu. yds. of earth and 10,000 cu. yds. of rock excavations, 300,000 cu. yds. of embankment, 320 ft. of steel, and about 7,200 cu. yds. of masonry. Mr. C. L. Hervey is the engineer.

In connection with the prospective award of contracts for the construction of the proposed bridge over the Second Narrows, B.C., a modified scheme on the previous alternative bid submitted with the tenders on the Wolfe-Barry designs has been outlined by Mr. C. A. P. Turner on behalf of the Western Foundation Company, Toronto. The two next lowest tenderers, the Dominion Bridge Company and the Canadian Bridge Company, are to be given the opportunity to submit bids on the Turner design. This provides for a structure of the same width and, accommodation, and follows the general lay-out of the British engineers' plans. The longer span will avoid piers in the deepest part of the channel, provide a wider fairway for small boats and afford less resistance to the tides. The substitution of reinforced concrete caissons for steel cylinders is proposed.

Personal Mention

Mr. C. D. McArthur has been appointed general manager and chief engineer of Foley Bros., Welch, Stuart & Farquier, of Halifax, N.S.

Mr. Archibald Currie, city engineer of Ottawa, who recently had a severe nervous breakdown, is, we are glad to learn, well on the road to recovery. He has been in Atlantic City for some time.

Sir. Jos. Wilson Swan, inventor of the first incandescent electric lamp, died at London, Eng., on May 27, aged 86 years. He was born at Sunderland, Eng., and was the inventor of many other electrical devices, including a miner's safety lamp and an electric meter. At one time he was the president of the British Institution of Electrical Engineers.,

Mr. G. D. Archibald, who, as announced in our issue of May 6, has been appointed City Engineer of Saskatoon, Sask., is an Associate Member of the Canadian Society of Civil Engineers, and has been for the last two years engaged as contractors' engineer on pavement work in Canada and the eastern States. He was also for a short time on Section 2 of the new Welland Ship Canal at St. Catharines. Mr. Archibald began his engineering life in 1900 as rodman, draftsman, etc., for the Nova Scotia Steel and Dominion Iron and Steel companies in Nova Scotia. He then went to the Grand Trunk Pacific in Western Canada on location and construction work, and later, from 1907 to 1912, was engineer in charge of maintenance and construction for the Canadian Northern Railway.

Mr. L. B. Merriam, C.E., Winnipeg

Mr. L. B. Merriam, consulting engineer, Winnipeg, whose article, "Estimating the Cost of Earthwork and Concrete Construction," is a feature of this issue, was born in the State of Connecticut in 1860. Graduating from the University of Illinois he served in the engineering departments of several railways in various capacities on location or construction work. In 1890 he entered the service of the Chicago and North-Western Railway and soon became Assistant Division Engineer, a capacity in which he remained until 1896, when he opened an office in De Kalb, Ill., and became engaged in general consulting engineering. During the years following he carried out a number of important commissions for large railroads in the United States. Mr. Merriam came to Canada in 1906 and shortly afterwards was appointed Division Engineer of the Grand Trunk Pacific, with headquarters at Winnipeg. Three years later he established an engineering office in Winnipeg. He has had charge of several important undertakings and has acted in an advisory capacity on contractors' estimates and equipment. During all the years from 1890 until the present time, Mr. Merriam's work has been largely the organization and direction of labor forces employed directly by the companies represented.

Mr. L. B. Merriam, Winnipeg.

Mr. Richard Carter Dancy, Pioneer Toronto Contractor

One of Toronto's pioneer contractors is Richard Carter Dancy, whose specialty is plastering. He was born in Sussex, Eng., in 1852 and came to Canada at an early age. He was educated in Toronto and learned his trade in that city. Afterwards he went to the United States and worked in the principal cities on the other side of the border for twelve years. He returned to Canada in 1883 and carried on a contracting business with his brother under the firm name of Dancy Brothers. During this time he was Managing Director of the Toronto Pressed Brick & Terra Cotta Company. He has been engaged in his present line of business about seven years and has completed some of the largest plastering contracts in Toronto. His work includes: the Traders Bank, the Toronto General Trust Building, the Royal Alexandra Theatre, the Bank of Toronto, the new Y. M. C. A., and the Bishop Strachan School, all in the Queen City. Mr. Dancy's military connection is worthy of note. He served with the 10th Royal Regiment for ten years and saw active service during the Fenian Raid.

Mr. R. C. Dancy, Toronto.

Hon. Angus McDonnell, of the firm of Grant, Smith & Company and McDonnell, Limited, contractors for the construction of the concrete piers in connection with the extensive harbor scheme at Victoria, B.C., has returned to British Columbia after his recent marriage.

Mr. W. C. Brennan, formerly secretary of the Hamilton board of works. was recently appointed Commissioner of Public Works and Streets at Fort William, Ont.

Messrs. W. F. Stanley & Company, Limited, 286 High Holborn, London, Eng., are the sole manufacturers and patentees of a patent Swivel Nib Drawing Pen, which draughtsmen will find a valuable acquisition. The improvement on the older forms of drawing pens is considerable, as the nibs can be opened out instantly for cleaning and replaced afterwards without interfering in any way with the original adjustment and the thickness of line.

Mainly Constructional

East and West—From Coast to Coast

EASTERN CANADA

The new plant of the Mount Royal Brick Company, Limited, at Varennes, Que., will be in operation early in June.

The Hamilton, Ont., city council are considering the installation of an over-flow sewer system at a cost of $500,000. A. F. Macallum is city engineer.

Solid rock has been struck at a depth of 85 feet as a result of boring tests made for the foundation of a proposed high level bridge at St. Catharines, Ont.

At Fort William, Ont., the site for a new armoury, at a cost of about $180,000, has been selected. Contracts will be let shortly for the building which will be constructed this year.

The Building Department at Montreal has been reorganized and a number of new appointments made. The salary of Mr. Alcide Chausse, building inspector, has been raised from $2,500 to $4,000.

Hyslop Bros., of Dundas, Ont., have decided to establish their western Canadian headquarters in Regina. The firm has secured temporary quarters in the city warehouse, but will erect a substantial building in the near future.

Work on the new government road from Lennoxville, Que., to Derby Line is going on rapidly. Mr. Darey, engineer to the contractors, Messrs. Doheny & O'Brien, expects to have the entire twenty-four miles completed by next year.

About one thousand men are at work with six steam shovels and eight locomotives on the construction of the railway from Woodstock, N.B., to St. John. About 120 miles of the line between Gagetown and Centreville will be completed this year.

The city of Westmount, P.Q., has decided on an open competition for plans for the new City Hall. Premiums of $150 each will be given to four architects whose plans are selected by the adjudicators, Mr. F. S. Baker, of Toronto, and a committee appointed by the Council.

Recent reports from Fort William indicate that the mining industry is becoming active in that locality. Important discoveries of minerals north of the city were made recently by Professor F. Von Hille, mineralogist, who is said to have secured samples of gold, nickel and platinum.

Seventy residences, estimated to cost $210,000, are to be erected in the city of Quebec by Henry Gaffney, 204 St. James Street, Montreal, who is the owner, architect and general contractor. Operations will be commenced about July 1, when tenders for the several trades will be received.

The City Council of Toronto have come to an agreement with Messrs. Hazen & Whipple, the New York engineers who prepared plans some time ago for a duplicate slow sand-filtration plant at Toronto Island. The firm presented a bill amounting to $32,335, but have now agreed to accept $10,800.

Thirteen grain elevators have been purchased by the N. M. Paterson Grain & Elevator Company, Fort William, Ont. These elevators, which were formerly owned by the Royal Elevator Company of Winnipeg, will be operated in conjunction with the terminal elevator at present in use by the Paterson Company.

The Mount McKay Products, Limited, manufacturers of pressed and common brick and clay products, were reorganized recently at Fort William, Ont., under a new charter, with a capital of $500,000. The plant is situated at the foot of the mountain where shale is obtained by gravity, and four new brick kilns are in course of construction.

Foundation work for the Old People's Home, which is to be erected at St. Laurent, Que., at a cost of $250,000, has been completed. The owners are the Order of Grey Nuns and the general contractors the Atlas Construction Company, Belmont Street, Montreal. The building will be three storeys high, 200 ft. by 80 ft. in dimensions, of reinforced concrete construction.

A contract for the erection of a new Rosemount school for the Montreal Protestant Board of School Commissioners has been awarded to Messrs. A. F. Byers & Company, Limited. The contract price is $121,000. Messrs. Nobbs & Hyde, Montreal, are the architects. The same firm of contractors are building a new dry cleaning house and boiler house for the Toilet Laundry Company, from designs by Hutchison, Wood & Miller, Montreal.

At Stratford, Ont., Mr. Davis Barnett, a member of the Stratford Water Commission which visited the waterworks convention at Philadelphia, U.S.A., this month, has issued a report dealing with several of the most important water filtration plants in the United States. He announces that all the large filters that have been installed in the states in the last three years are some form of the quick-acting mechanical type of filter adopted by Stratford.

The Ontario Government is actively engaged in the work of road construction throughout the province, a six-mile stretch of macadam road work having been completed recently at Fort William, Ont. Another six miles will be added to the same road and it is said that a road extending from Fort William to the International boundry line, a distance of 42 miles, will be cut this year. The Ontario government is working in conjunction with the government of the United States for the building of an automobile highway between Duluth and Fort William.

WESTERN CANADA

Building permits at Regina, Sask., for the first half of the month of May amounted to $350,000.

At Prince Albert a by-law to raise $250,000 for a street railway system is to be submitted to the ratepayers.

A clay products plant is to be erected at Le Pas, Man., by The Pas Clay Products Mining & Development Company, which is capitalized at $50,000.

The plans for the $250,000 sewer system that the council of Redcliff, Alta, will submit to the ratepayers in June, have been received from Mr. W. J. Francis, C.E.

Foundation work is in progress for the $300,000 temple which is to be erected at Cardston, Alta., for the Church of Latter-Day Saints. The architects are Messrs. Pope & Burton, Salt Lake City.

At Medicine Hat, Alta., the contract has been let to Messrs. Geo. H. Archibald & Company, Limited, contractors, Winnipeg, for the construction of a mill for the Maple Leaf Milling Company. Work on the new plant will be started almost immediately.

The Winnipeg Board of Control has awarded contracts for the making of pavements at approximately $200,000. Mr. H. N. Ruttan is the engineer in charge of the work, which is being carried out by the general contractor, Mr. J. W. Astley, Superintendent of Construction.

The hotel to be erected at Regina, Sask., for the Grand Trunk Pacific Railway, at a cost of over $1,000,000, will be completed in August, 1915, according to an announcement made by Mr. Morley Donaldson, vice-president and general manager of the company.

The Vancouver Portland Cement Company and the Bamberton Cement Company have secured the contract for 100,000 barrels of cement for the concrete cribs in connection with the pier construction scheme at Vancouver.

Calgary ratepayers have approved a by-law authorizing the expenditure of $512,600 for the erection of a concrete bridge and a steel bridge over the Bow River and a concrete bridge over the Elbow River. The City Engineer is Mr. Geo. Craig.

The new sanitary plumbing by-law being prepared by the Sanitary Inspectors' Association of Western Canada will contain a clause providing for reducing the height of the sewer ventilation shafts above the roofs of buildings, in order to eliminate trouble caused by ice caps on the ventilation terminals.

The Alberta Town-Planning and Housing Association will convene at Calgary, Alta., June 16-18 next. Precedence will be given to the consideration of the proposed housing bill for the province of Alberta. The Mawson plans for the city of Calgary, as well as civic plans for the various cities of the Dominion, will be on exhibition. The proceedings will be opened by the Lieutenant-Governor of Alberta.

A new Pantages theatre which was opened a few days ago at Victoria, B.C., by Sir Richard McBride, Premier of British Columbia, has a seating capacity of 1,000. The building is of steel and concrete construction and involved an outlay of approximately $150,000. The proscenium opening is 32 ft. in width, while the stage proper is 28 ft. in depth and 58 ft. from side to side. The main entrance to the building is semi-circular in shape, with rich marble panelling on the walls. The "sprinkler" system of fire protection is installed with four hundred automatic fusible spraying heads. Mr. Jesse M. Warren was the architect, the contractors being the British Columbia Construction & Engineering Company.

Canadian Railroad Development

The province of New Brunswick has secured government aid to the extent of $3,000,000 for the construction of three bridges for the St. John River Valley Railway. The entire cost will be borne by the Dominion government. After a period of fifteen years a rental based on the proportion of the cost of the bridges to that of the whole line will be charged. Of the three bridges one will be built at Andover, the second near Dunn's wharf, and the third across the Kennebecasis River.

The Canadian Pacific Railway has erected seven gates that will be operated automatically by electricity, to safeguard traffic across its tracks along the Vancouver water front. The gates are of the portcullis type and will be raised or lowered by pressure of an electric button. The company will expend seven million dollars this year in double-tracking its line between British Columbia and western points. In addition it will expend about eleven millions on similar improvements on Eastern divisions.

It is announced that the Western Dominion Railroad will construct a line down the valley from Calgary, Alta., to the oil fields. Instead of building one hundred miles of road as was at first intended, the line will be carried south to the International boundary, there to be met by a branch of the Chicago, Milwaukee and St. Paul line, now building from Great Falls. The road has been financed by a joint syndicate of London and New York capitalists, and the work will be commenced immediately.

At Amherst, N.S., a good deal of bridge work is to be carried out this year on the Intercolonial Railway. Over one hundred steel bridges will be strengthened so as to accommodate heavy power from Truro to River du Loup, and contracts for over forty have already been let to various bridge contracting companies in Canada. The Rhodes Curry Company, of Amherst, have been awarded contracts by the Dominion government for nine girder bridges. The steel to be used in these will be imported in channels and fabricated at the Amherst shops of the Canada Car & Foundry Company.

Sixty steel and wood bridges, ranging from seventy-five to one hundred and twenty-five feet in length, will be required in a distance of eighteen miles on the Central Canada Railway north of Edmonton, for which route plans have been filed with the Provincial Department of Railways for Alberta. Engineers report that at least 50,000 yards of earth will have to be removed from every mile of line on the roadway along the North Hart river, and that the cost to construct this stretch of line will be more than $50,000 a mile or $30,000 a mile in excess of the bonded obligation of the provincial government. It is the intention to span the Peace river with a steel bridge at a cost of $400,000, thence the line will continue to Dunvegan, along the north bank of the Upper Peace river.

International Engineering Congress, 1915

Among the general subjects to be treated before the International Engineering Congress (San Francisco, September 20-25, 1915), probably the one having the broadest interest is that of Materials of Engineering Construction, which enters into all phases of engineering activity.

The list of topics which will be treated in this section is as follows: (1) Timber. (2) Preservative Treatment of Timber. (3) Substitutes for Timber in Engineering Construction. (4) Brick in Engineering Structures. (5) Clay Products in Engineering Structures. (6) Probable and Presumptive Life of Concrete Structures made from Modern Cements. (7) Aggregates for Concrete. (8) Slag Cement. (9) Waterproof Concrete. (10) Cements containing Additions of Finely Ground Foreign Material. (11) Economics of the World's Supply of Iron. (12) The Life of Iron and Steel Structures. (13) The Employment of Special Steel in Engineering Construction. (14) The Place of Copper in the Present Engineering Field, and of Economics of the World's Supply Thereof. (15) Alloys and Their Use in Engineering Construction. (16) Aluminium in Engineering Construction. (17) The Influence of the Testing of Materials upon Advances in the Designing of Engineering Structures and Machines. (18) Cement Testing. (19) Testing of Metals. (20) Testing Full-Sized Members: (21) Proof Testing of Structures.

The papers to be presented from the United States have already been arranged for from the recognized leading authorities on the various topics. Arrangements for the papers from foreign authors are being rapidly concluded, and the aggregation of papers which will be presented will constitute a broad review of the field and be of the highest value.

Marked interest in the Congress from foreign countries continues, and there is every evidence that the attendance from abroad will be large. It is hoped that all engineers in this country who have not yet subscribed as members of the Congress will give the matter their immediate attention and favorable action.

Full information concerning the Congress, the price of subscription, and the arrangement for purchase of volumes of the proceedings, may be obtained by addressing the Committee of Management, as follows: International Engineering Congress, 1915, Foxcroft Building, San Francisco, Cal.

Plant and kilns of the National Builders' Supply & Enamel Concrete Brick Company, Limited, at Mascouche, Que.

An Up-to-date Plant for the Manufacture of Enamelled Concrete Brick

Erected and Equipped at Mascouche, Que., by the National Builders' Supply & Enamel Concrete Brick Company, Limited, Montreal

IN this age of concrete, one hardly needs reminding of the durable qualities of that material. The problem of manufacturing it into brick form and of facing it with an enamel finish has been the subject of many experiments, it being recognized that if successfully solved, the product would be a brick of great permanent characteristics. The result of several years' experiments and the expenditure of a large sum of money was the invention of the machine made by the Enamel Concrete Brick Company, Des Moines, Iowa. The bricks have been extensively used in the United States, and are now being manufactured in this country by the National Builders' Supply and Enamel Concrete Brick Company, Limited, of 30 St. Francois Xavier Street, Montreal, at Mascouche, P.Q., who hold the exclusive rights for Canada. The capital is provided by a Franco-Belgian syndicate, and it is intended to erect about ten plants throughout the Dominion. For that purpose several machines have been ordered, and the company are also negotiating for the right to install the machines in Europe.

View of engine room.

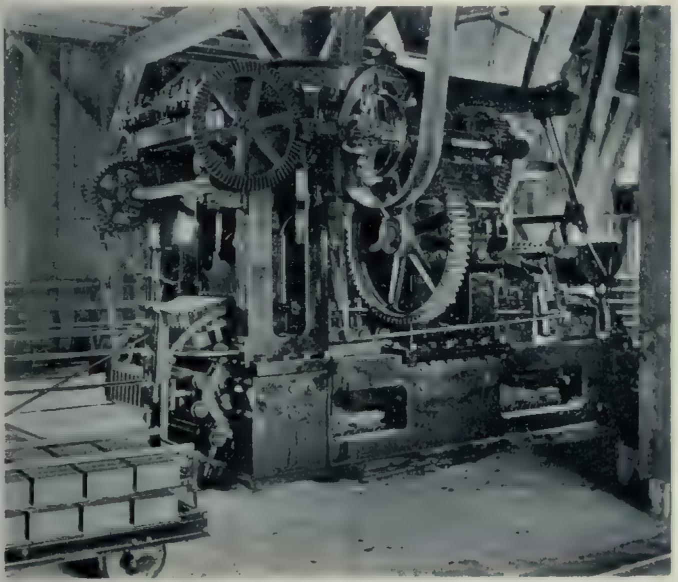
The plant at Mascouche, 26 miles from Montreal, has just been installed from the design, and under the superintendence of Mr. H. C. Harding, the managing director. The company own 147 acres of land yielding a very fine sand, well adapted for manufacturing the brick; it is composed of felspar and quartz—practically a pure silica sand. An option on an additional 600 acres is held by the company. The bricks are composed of sand and cement, and are made either in the form of enamel, pressed, or moss finish, and in fifteen standard shades, although any desired color can be obtained. It is claimed that they are fireproof, waterproof, sanitary and artistic, and can be adapted to every use to which building stone or brick can be supplied.

The works comprise a mill, oil-house, camp, storeroom and offices, engine-house, forge fitted with a complete equipment for repairs, and a laboratory and testing room.

The mill is strongly built of lumber, and is capable of extension; in fact it will be shortly enlarged to allow of the installation of another machine. One of the features is the automatic action of the entire machinery, hand labor being eliminated wherever possible. The sand is conveyed to the ground floor, where it is fed into an American Process dryer; this machine is 6 ft. in diameter and 42 ft. in length and rotates at 6 revolutions per minute. When dried the sand falls into a boot and is elevated to the third floor, where it passes over a screen, the stones being thrown into a shoot at the side. As the coarse sand passes into a bin it can be screened a second time by an ingenious screen, the idea of Mr. Harding, controlled from the floor below. Should this finer sand be required, a lever is pulled and the sand, instead of going into the sand bin on a conveyor, passes over a smaller screen and into a spout leading to the next floor. On the third floor is situated the bin for the cement, to which this material is elevated from the second floor, where the bags are hoisted direct from the railway cars. The materails stored on the top storey pass down to the next room as they are wanted, the supply being regulated by the man in charge of the mixing machine. The responsibility for the smooth running of the mixing, etc., rests upon this employee, who controls the quantities of materials coming from the bins, the moisture of the mixture, and the regularity with which the materials are fed into the press on the ground floor. Near him is fixed a card dial, with various directions as to the mixture and the running of the machines; this is connected with the press on the ground floor, and if any more moisture is required, the men at the press signal by means of the dial and the alteration is made. After the cement and sand have been mixed and a certain amount of water added to give the right consistency, the mixture flows into eight individual scale hoppers, thus automatically measuring the materials for each brick. These hoppers automatically dump the material through receiving spouts leading into the eight moulds of the press below. This press is very heavily built, and weighs 36½ tons. The eight moulds are subjected to a pressure of 3,200,000 pounds, forming the material into strong hard bricks, which are delivered from the machine eight at a time. This is the method of manufacturing the common concrete brick.

When an enamel face is required, an additional process comes into operation. On the second floor there are the color vats for mixing whatever color is desired. The liquid drops into a series of eight cups attached to the press on the ground floor; these cups automatically deposit the liquid into the moulds, which then receive from a mixer on the second floor a special mixture of fine sand and cement, this deposit acting as a cushion on top of the liquid enamel facing. The remaining portion of the moulds are filled by the body or backing material of which the common concrete brick is made, and which has been delivered to the press as described in the preceding paragraph. The mould boxes are subjected to the heavy pressure referred to, which unites and amalgamates the facing cushion and backing materials into one cohesive mass for each of the eight bricks.

The bricks are released resting on the steel pallets on which they are made. There are 14,000 of these polished pellets, which after being used are oiled and cleaned by a special machine erected near the press. The latter has a capacity of 35,000 to 40,000 bricks per day. On the ground floor there are also two hand machines for making special bricks.


Brick press machine.

After coming from the press, the bricks are placed on folding deck cars—of which there are 125—and conveyed on rails to the four steam curing tunnels, each 140 feet long. Here the bricks are subjected to a high pressure for 24 hours, and later transferred to the loading sheds ready for shipment. The steel cars are of very ingenious construction, and permit of a minimum of handling. Four additional kilns are now being built.

The mill is about half a mile from the railway station, and the C. P. R. have put in a special siding, which allows railway cars to be loaded from both sides of the sheds, which have a capacity of seven million bricks.

The boiler house and engine room is an exceptionally well-lighted and spacious department. The boilers, manufactured by the Goldie and McCullough Company, Galt, Ont., are two in number, and each of 125 horse-power. They are coal fed, forced draught being provided by a ten horse-power upright engine and by a blower made by Sheldons, Limited, Galt. In the boiler house is a National feed water heater fed by a Blake duplex feed pump 6 x 4 x 6. The tank in the mill is fed by a duplex pump supplied by the Smart-Turner Machine Company, of Hamilton. The engine, of 200 horse-power, is by the Jenckes Machine Company, Sherbrooke, P.Q.

The plant is electrically lighted, there being 200 lights in all, with 1¼ miles of wire. The engine is the Ideal, while the d.c. generator, 115 volt, 60 amp. and 1,800 r.p.m. was manufactured by the Canadian General Electric Company, who also supplied a small lighting panel. All the refuse oil is filtered by a Simms oil filter.

Water is supplied from a reservoir with a capacity of 80,000 gallons, which serves the double purpose of draining the land and giving an ample supply of water for the plant; it is very pure, being filtered through the sand. It is pumped direct into the boilers and into a large tank at the top of the building. Near the reservoir is a platform for loading sand for the Montreal market, this platform having a capacity of 25 cars per day.

A large amount of the iron and accessories for the building were supplied by the Canadian Fairbanks Morse, Limited, Montreal; the conveying apparatus by the Jeffreys Manufacturing Company; and the belting by the J. C. McLaren Belting Company, Montreal.

Baystate Brick and Cement Coating

The concrete contractor who has had difficulty in waterproofing his buildings will appreciate the merits of Bay State Brick & Cement Coating as manufactured by Wadsworth-Howland & Company, 82-83 Washington Street, Boston, Mass., and described in their Booklet 10. This booklet contains a great many photographic reproductions of buildings in which this waterproofing has been used, together with a long list of buildings in practically every state in the Union. It also contains a color card showing the various colors in which it can be obtained and from which practically any desired shade can be made. The object of Bay State Brick & Cement Coating is to decorate and protect concrete, cement, stucco and brick surfaces. It overcomes the dull, monotonous color of ordinary Portland cement, and prevents such surfaces from showing any spots, blotches, discoloration or dampness after a storm. By filling all of the pores in the surface, it prevents air cracks and other disfigurations. When metal lath is used with stucco, this compound prevents any moisture getting to the lath and so prevents the deterioration of it. By excluding dampness, it preserves all of the building materials, as well as insures a dry inside wall. Bay State Brick & Cement Coating can be used not only on the exterior but on the interior, where it gives the soft, velvety effects of water color. As it is unaffected by dampness, it has far greater durability than any other of the products used for this purpose, and it can be washed without injury. It is one of the few compounds which bears the label of the National Board of Fire Underwriters, and when used on wood tends to lessen the fire risk.

An illustrated catalogue of Iroquois road and street paving machinery and tools received from the Barber Asphalt Paving Company, Buffalo, N.Y., is suggestive as to the possibilities of this equipment. The various lines shown and described include tandem rollers, macadam road rollers, portable heating kettles, double drum dryers, semi-portable bituminous mixing plants and asphalt and concrete mixers. The company also has a line of small tools which, in common with Iroquois machinery, are the outcome of twenty-five years' experience in the manufacture and use of equipment for paving and road building.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Berlin, Ont.
The city council has decided to install a filtration plant at Shoemaker's Dam, as the Board of Health has forbidden the further use of the water until a plant is erected.

Brocket, Alta.
Tenders will be received by Duncan Scott, Dept. of Indian Affairs, Ottawa, until noon June 8th, for excavating, concrete work, wood and galvanized iron piping and valves connected with the installation of a waterworks system for the Peigan Reserve. Plans and specifications are at the Indian Office Brocket, Post Offices at MacLeod and Lethbridge, and at the office of Woods & Steel, Civil Engineers, Pincher Creek, Alta.

Brockville, Ont.
Estimates are being prepared by the town council for the construction of tarvia roadway on King St. W., from Kingston Bridge to the town limits, and for the paving of Church Street, from Perth Street to the C. N. R. station.

Esquimalt, B.C.
Plans are being prepared for the construction of the third unit of the sewer system. The municipal council will call for tenders in the near future. Engineer, C. H. Topp, 211 Pemberton Blk., Victoria.

Hamilton, Ont.
The question of the construction of an overflow sewer system, at an estimated cost of $500,000, will be brought up by Ald. Littlewood at the next meeting of the city council.

London, Ont.
Plans are being prepared for the paving of King St. The cost is estimated at $8,000.

Moncton, N.B.
The town council are having plans prepared for extensions to the sewerage system.

Montreal, Que. (Pt. St. Charles)
Tenders will be received by L. N. Senecal, secretary to the Board of Commissioners, until noon, June 12th, for the construction at the low level pumping station, Pt. St. Charles, of a brick building, with concrete foundations and fireproof roof, etc., as per plans and specifications at the office of the Superintendent of Waterworks, City Hall.

Montreal, Que., St. Lambert
Tenders will be received by the engineer, E. Drinkwater, for the next two weeks, for the laying of sidewalks on 15 streets.

Niagara Falls, Ont.
Tenders will be received by the city council clerk, W. J. Seymour, or the engineer, F. J. Anderson, until noon June 30, for the construction of approximately 4,390 lin. ft. of 8 and 10-in. sanitary sewers. Plans are at the office of the Engineer, City Hall.

Orillia, Ont.
By-law providing for the remodelling of the waterworks system at a cost of $80,000 will be submitted to ratepayers on June 18th.

Ottawa, Ont.
The assistant city engineer, F. C. Askwith has been requested to report on the road equipment and machinery required by the city, so that the purchase can be made.

The laying of the following pavements is being considered by the city council. Macadam tarvia finish on Carling St., between Bank and O'Connor Sts.; asphalt pavement on O'Connor St., between Laurier and Lewis Sts.; treated wood block on Chapel St., between Anglesea Sq. and St. Patrick St.; wood block on Murray St., between King and Chapel Sts., and wood block on York St.

Port Moody, B.C.
A by-law providing for the construction of a reservoir and water supply system at a cost of $66,000 is to be submitted to the ratepayers. The water supply will be obtained from Noon and Scott Creeks. The engineers are Davis & Leslie of Vancouver.

Prince Rupert, B.C.
The Board of Works has recommended the laying of a 10-in. watermain in Sec. No. 2, a 6-in. main on 7th Ave., and a 6-in. main on 6th Ave. The total cost is estimated at $21,000.

Regina, Sask.
New tenders are to be called for the construction of a reservoir at Dewdney and Broad streets. The previous tenders were rejected owing to the change of location. Engineer, J. M. Mackay, Supt. of Waterworks.

Revelstoke, B.C.
The construction of pavements on various streets is being considered by the city council.

The city council has decided to construct cement walks on 3rd and 4th Sts.

Shellbrook, Sask.
The village council has received the permission of the Provincial Government to raise the sum of $2,500 for improvements to the sidewalks, streets and municipal buildings.

Truro, N.S.
The town council has decided to construct certain concrete pavements and sidewalks at a cost of $5,750. The work is to be done by day labor.

Toronto, Ont., Weston
Tenders will be called shortly by the town council for the construction of a new road on Main St., 1¾ miles long.

Victoria, B.C.
The city council has approved the paving of Cook street from Mears street to Rockland Ave. and Fairfield Road between Dallas Road and the city limits.

Vancouver, B.C.
The construction of the following sewers has been recommended by the engineer, F. L. Fellowes, on Garden Drive, $15,000; Lakewood, $3,560; 4th Ave., $2,670; 3rd Ave., $1,350; 2nd Ave., $1,265; Broadway, $1,100; 8th Ave. E., $2,600; 8th Ave., lane, $1,250.

Yarmouth, N.S.
The town clerk, Hiram Goudey, will be glad to receive prices on rock crushers, for road building purposes.

CONTRACTS AWARDED

Assiniboia, Man.
The rural municipality of Assiniboia has awarded to A. C. Vanhorenbeeck & Co., of St. Boniface, the contract for the construction of a sewer on Ness Ave.

Camrose, Alta.
The contract for sewer and waterworks extensions has been awarded by the municipal council to Chas. Gray, Prospect Ave.

Edmonton, Alta.
The following contracts for watermains and sewers have been awarded by the city council. McMahon & Graham, $80,000; C. L. DeVall, $53,000; Ross & McCabe, $33,000.

Montreal, Que., St. Lambert
The town council has awarded to E. Belanger Co., of 2820 St. Hubert St., Montreal, a contract for sewer construction.

Point Grey, B.C.
The municipal council has awarded to Robt. McLean & Co., of Vancouver, the contract for the sewer extensions on 48th Street.

Prince Albert, Sask.
The city council has awarded to The Red Wing Sewer Pipe Co., of Red Wing, Minn., U.S.A., a contract for the supply of 40,000 ft. of 15-in., 12-in., 10-in., 8-in., 6-in. and 4-in. sewer pipe, with unctions and specials.

Sherbrooke, Que.
Thecity council has awarded to J. S. Mitchell & Co., 73-77 Wellington St., a contract for the supply of 6-in. cast iron pipe, at $30.15; 8-in., at $30.15; 10-in., at $30.15; fittings, at $54.

Toronto, Ont.
The Board of Control has awarded contracts for various works to following: concrete sidewalks—Routly & Summers, 38 Benlamond Ave.; Queen City Concrete Paving Co., 179 Broadview

ESTABLISHED 1886

Contract Record
and Engineering Review

Published Each Wednesday By
HUGH C. MACLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 June 10, 1914 **No. 23**

The Business Outlook ... 735
Inefficiency Illuminated ... 736
The C. N. P. Railway Bridges of British Columbia .. 737-41
By John Lyle Harrington
Modern Tendencies in Equipping and Operating Structural Shops ... 741
Modern Bituminous Surfaces and Pavements ... 742-5
The Proper Care of Road Machinery ... 745
Repairing a Settling Bridge Pier ... 745-6
Compound Piling ... 746-7
Concrete vs. Other Materials for Factories ... 747
Field Connections in the Equitable Building, New York. 747
C. P. R. Hotel Paliser, Calgary ... 748-9
The Design of Steel and Reinforced Concrete Pillars .. 750-1
Frost Resistance of Building Stone ... 751
Subway Construction at Vancouver ... 752
The New St. Charles Hotel, Toronto ... 753
Proposed Industrial Building, Calgary ... 753
Methodist Book and Publishing House, Toronto ... 754-5
Government Examining Warehouse, Calgary ... 756
Vancouver and Coast Correspondence ... 757-9
Personal Mention ... 760
Constructional and Industrial News ... 761-3
Mixing and Placing Concrete by Compressed Air ... 764-5

The Business Outlook

BUSINESS generally in Canada at the present time is not what most of us would have it, but it is gratifying to find leading financiers agreed that the trade depression is of a very shallow character. Not infrequently Canada has provided an almost isolated example of continued prosperity, but in the very nature of the manner in which all her important constructional undertakings have been financed, and of the increased amount of outside capital that is coming into the country, she must be susceptible to the influence of outside conditions, particularly in the United Kingdom and the United States. Much will depend upon the character and extent of this year's crops in Western Canada, but much also will depend upon outside developments.

It is recalled how the British Chancellor of the Exchequer in presenting his 1913 budget went contrary to expert opinion and predicted a prosperous year. And it proved to be right, for his estimates of revenue were exceeded by $15,000,000; the country's commerce reached a record point, and in general prosperity England surpassed her trade rivals. The success of this prophetic utterance does not necessarily ensure uninterrupted accuracy in the Chancellor's predictions, but it is sufficient to command attention. In his budget speech Mr. Lloyd George expressed the opinion that the present depression would be a shallow one and would not last long.

In the United States the conviction that the country will enter upon a decided forward movement before fall is based largely on the excellent crop outlook. And besides, the belief is growing that the period of extreme governmental and legislative attack on big business is drawing to a close. In all parts of the Union, business men have been roused by the effects of the numberless laws and projects for having Government officials forever meddling or interfering with business men. Trade and industrial activity has been artificially restrained through fear of legislative aggression. Business has been held back for months.

The United Kingdom has been affected by purely European developments and by the course of events in Mexico, Brazil and East India. In many of these cases there are signs of improvement and it can be taken for granted that Great Britain would benefit more than any other country from a pronounced revival in the United States. When the people on the other side of the border are very prosperous, British trade always benefits; and since the lowering of the United States customs tariff the British stand to gain a great deal more profitable trade. Thus, if the above forecasts or theories should turn out to be correct, we should see a good improvement in conditions in the neighboring country and in the mother country.

The question arises as to the extent to which our business would be influenced. In calculating this it is necessary to ask whether circumstances peculiar to ourselves will operate on this occasion to lessen or restrict our participation in the prosperity of the other countries. It is probably the case that conditions now prevailing in Canada would prevent any sudden upward bound on our part. Necessarily the improvement here must be gradual. A great deal will depend on this year's crops in Western Canada. A good yield would help. And if the prices received by producers are such as to give them reasonable profits so much the better. Another requisite is that the British market take our good bonds and debentures in large volume on satisfactory terms. Perhaps it is vain to hope that our securities will command immediately a free and advantageous market abroad. English investors now think we have borrowed too much lately, and many of them have burned their fingers in Canadian propositions. So it may take a little while to re-establish our position in London. But, in the meantime, if trade in the United States and Great Britain enters a new era of prosperity, there must necessarily be a quickening of our industry and trade also.

Inefficiency Illuminated

LIFE is nothing if it be not relieved occasionally by a touch of humor. Shortcomings, municipal and otherwise, cannot fail to amuse sometimes, for inefficiency can be carried to a point where it becomes ludicrous. It is possible to pass from indignation to a state of entertained passivity.

So we feel about the town of St. John's, P.Q. In this enlightened Quebec municipality we have a correspondent whom we asked to report upon the various municipal systems in operation and to give us some information about the manner in which local affairs were administered. We had hoped to incorporate the details in the Alphabetical Reference to Canadian Towns and Cities published recently in this journal, but the communication came in tardily—not altogether to the disadvantage of St. John's, perhaps.

Below we give our correspondent's report upon St. John's, culled word for word from his letter.

Roadways.—Macadam. Mostly in a rotten state.
Sewerage.—No system. A sewer is dumped down regardless of any system and the sewage empties into the Richelieu River.
Garbage.—Allowed to collect in yards until it smells too high.
Water Supply.—From Richelieu River. About two thousand cases of typhoid and paratyphoid in the town last winter and spring.
Electric Light.—Good service.
Present Mayor.—A butcher.
City Clerk.—Efficient, but council-ridden.
Commissioners.—No-one appointed. Every councillor thinks he is one.
City Engineer.—Office held by the bailiff, chief of police and general utility man.

One redeeming feature about St. John's would appear to be the electric light service. All we can say is that we shall hope to hear before long that the administrators of the municipality have become enlightened mentally as well as physically. The above extract is illuminating as to why we found it impossible to obtain **official** particulars from St. John's for our Alphabetical Reference.

St. John's is a town with a population of some seven thousand. Is its record one of many or one among many?

An Experiment With a Fallacy

THE strikers in the Federation of London Building Industries have taken over the contract for the new structure for the Theosophical Society—a building which involves the expenditure of $500,000.

The move is a socialistic one and we are told that its end is the elimination of the contractor. This idea has been popular in British labor circles, but it has been difficult to get it under way owing to the fact that all building materials in England are controlled by syndicates whose interests are bound up with the contractors. There are eleven unions in the Federation, but funds are low owing to the fact that the strike has been in progress for more than four months.

It will be interesting to watch what success attends this latest socialistic development in the old land. It is possible that the officials at the head of the unions are sufficiently able men to take over the duties of the contractor and that the emoluments which they receive are sufficient inducement for them to do so, but it is safe to assume that in this instance, as in all others, the profit to which the contractor is entitled legitimately by virtue of his skill and experience will go somewhere—that it will be squandered at least in part, and that those who expect to benefit from the scheme will be disappointed.

Success in any enterprise is dependent upon efficient business administration. From such efficiency alone, provided their interests be sufficiently protected, can employees in the building or any other trade hope to benefit. The history of administration by social reform bodies has not been an encouraging one.

Mr. H. K. McCay, the city engineer of Baltimore, gives an interesting account of the efforts made to protect steel bridges over railways against the corrosive action of gases and cinders from locomotives. In the case of two important bridges it was found that the lower members were badly corroded in spite of frequent repainting. Consequently, the girders have been encased in reinforced concrete, which has been applied for the same purpose elsewhere with highly satisfactory results.

The supplementary estimates tabled at Ottawa total $17,438,912. An important item is $655,000 for the construction and completion of a dredging plant in the River St. Lawrence. There is a vote of $100,000 for harbor works at Goderich. One million is provided for the N. T. R., one million for the Quebec Bridge, and one million for the Welland Canal work. The sum of $500,000 is placed in the estimates for Port Arthur and Fort William harbor improvements, and the same amount is set aside for similar work at Quebec. For harbor works at Hamilton the sum of $250,000 is appropriated and for wharves in the Winnipeg harbor $200,000. A large sum will be spent upon the erection of public buildings and extensions to existing structures.

In an editorial note on fire-proof construction, the Sanitary Record points out that in fire after fire it has been demonstrated that unprotected ironwork only helps to destroy buildings "by expanding and pushing out the walls or yielding under the heat and pulling them down." After referring to slow and costly experience of so-called methods of fire-proofing, our contemporary makes the following remarks upon reinforced concrete:—"Whatever may be the opinion of architects as to its adaptability, there is no doubt that its proved fire-resisting and other desirable qualities ought to secure its use for the structural portion of all large buildings. We are afraid, however, that safety alone is not a sufficient inducement to adopt it, and not until architects and capitalists find that it is really an economical method of construction and makes a good foundation for adornment, shall we see it as widely used as we think it should be."

The Canadian Northern Pacific Railway Bridges of British Columbia

Specially Contributed by John Lyle Harrington*

THE Canadian Northern Pacific Railway, coming east from Vancouver, crosses the Fraser River at New Westminster on the bridge built in 1904 by the Province of British Columbia, and proceeds up the southerly bank to Cisco, where it crosses again to the north side of the river, only to return at Lytton. It then proceeds up the Thompson River, crossing it seven times, and crosses at its mouth and continues up the North Thompson River. Between Yale and Cisco the road crosses on steel spans and trestles nine creeks which enter the Fraser River from the south.

The earlier construction of the Canadian Pacific Railway secured for it the easier course up the north side of the Fraser River to its crossing at Cisco and thence up the southerly side of the Fraser and Thompson Rivers, but the difficulties of construction involved by the less advantageous course remaining unoccupied were greatly increased by the adoption by the Canadian Northern Pacific Railway of low gradients and very easy curves. The narrow, rough canyons compelled the line to cross the rivers frequently, often on curves and at points where construction was difficult and expensive. At most of the crossings the rivers are so swift and their flood depth so great that the construction of foundations was difficult and the erection of superstructures by means of the usual false work impossible. The plant and materials for the construction of the foundations for spans and viaducts between Yale and Cisco had to be taken across the swift and treacherous Fraser, sometimes by boat and often by overhead cable. Add to these a sparsely-settled country, scant means of communication, and distant sources of all labor, material and supplies, and the difficulties encountered in constructing so large an amount of bridge work are rarely equalled.

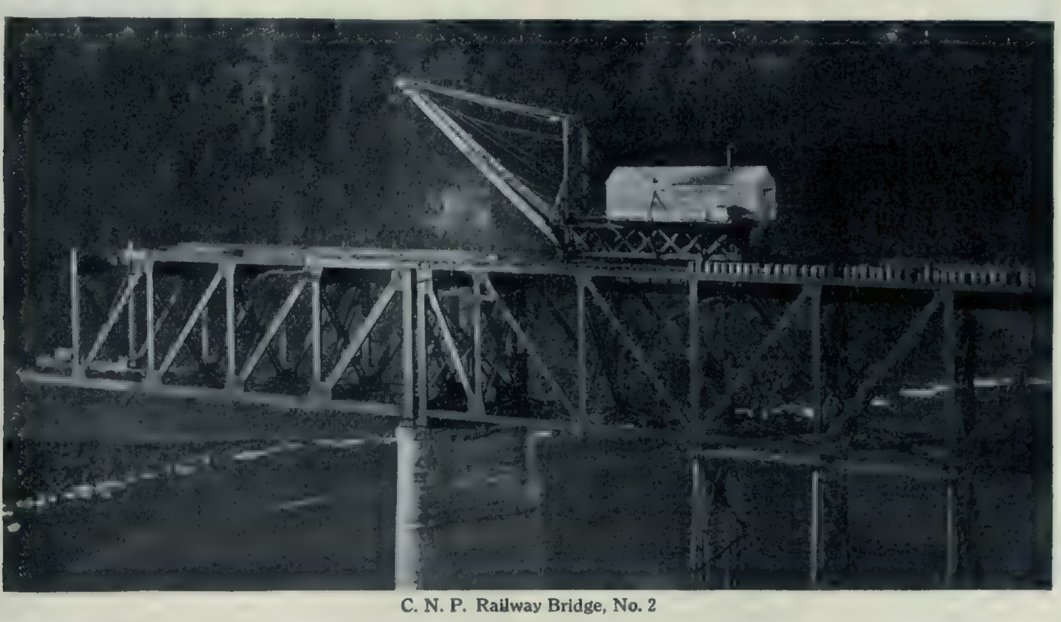
In the main, the structures themselves are not unusual. All have concrete foundation and steel superstructures with timber floors, designed for single track class heavy loading and in accordance with Dominion Government specifications.

Creek Crossings

Bridge No. 11 consists of two 35-ft. girder spans and one 90-ft. span. supported on abutments and a single trestle tower.

Bridge No. 12 has a total length of 910 feet and is made up of 35-ft. and 70-ft. girder spans on steel towers, having a height of 107 feet from base of rail to masonry. The entire structure is on a 4-degree curve.

Bridge No. 13 is 720 feet long and 105 feet from base of rail to masonry, and is made up of 40-ft. towers and 40-ft., 60-ft. and 80-ft. deck-plate girder spans. Bridge No. 14 is about 300 feet long, 100 feet high, and consists of 40-ft. towers and 40-ft. and 90-ft. deck-plate girder spans. Bridge No. 15 consists of one 35-ft. and one 90-ft. deck-plate girder spans resting on masonry. Bridge No. 16 is a single 75-ft. girder span. Bridge No. 17 consists of one 50-ft., one 90-ft. and one 15-ft. girder span, all resting on masonry. Bridge No. 18 consists of one 70-ft. girder span. Bridge No. 19 is one 60-ft. girder span.


C. N. P. Railway Bridge, No. 2

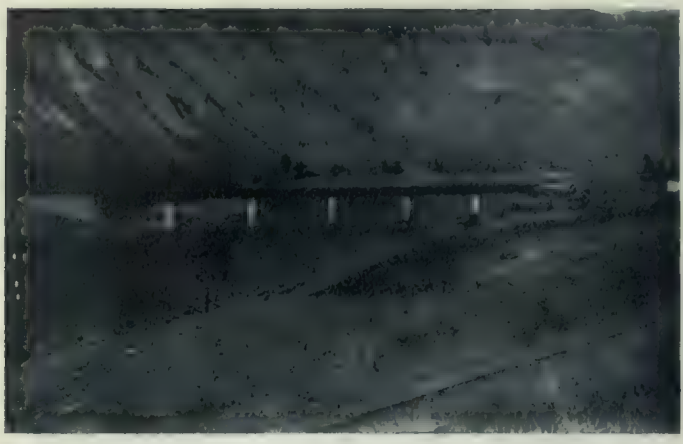
Bridge No. 1

Bridge No. 1 crosses the Fraser River at Cisco, where the stream is narrow, the water is swift, and the variation between low and flood water is substantially 80 feet, and where, consequently, false work is impossible. It consists of about 350 feet of steel trestle approach on the east end, and a three-hinged spandrel-braced arch, 425 feet long, centre to centre of end pins, having a rise of 90 feet and a truss depth of 20 feet at the centre and 110 feet at the end. The distance centre to centre of trusses is 14 feet, and they are battered 1½ inches per foot.

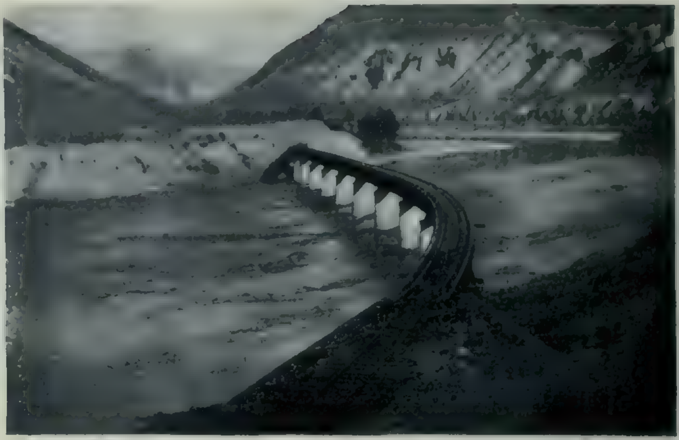
The foundations are comparatively inexpensive, for on the east side the skewback is placed on solid rock, approximately at the elevation of high water, although on the west side of the river it was necessary to excavate several thousand cubic yards of loose or dis-

---

* Of the firm of Messrs. Waddell & Harrington, Consulting Engineers, Kansas City, Mo.



C. N. P. Railway Bridge No. 6



C. N. P. Railway Bridge No. 7

integrated rock to secure satisfactory foundation in the face of the bluff, which at that point is almost sheer.

The superstructure will be received on the Canadian Pacific Railway tracks on the east side of the river. The easterly half of the arch will be erected as a cantilever supported by temporary counterweights bearing on the skewback. The material for the west half of the arch will then be carried out over the east half and run across to the west shore on cableways extending from the middle panel point of the arch to the west skewback. From the cableways it will be lifted by the traveller as needed in the erection of the west half of the arch, which will be erected as a cantilever, from temporary anchorage in the solid rock of the bluff. Fig. 1 is an elevation of the bridge.

Bridge No. 2

Bridge No. 2 crosses the Fraser River at Lytton, which is just below the mouth of the North Thompson River. It has a total length of 805 feet, consisting of two 68-ft. deck-plate girder spans at the easterly end, a mid-river span of about 295 feet flanked by two truss spans of about 155 feet each, and two deck-plate girder spans, each about 60 feet long, at the westerly end. The crossing is on a skew of about 65 degrees. The distance between low water and the base of rail is about 126 feet, and between low and high water about 70 feet. The piers are therefore very high, but since the foundations are shallow their construction otherwise involved no extraordinary difficulties.

The girder spans are being placed in the usual way. The 155-ft. deck truss spans are being erected on falsework, but the 295-ft. central span is being erected as a cantilever, one-half from each side, supported during construction on the 155-ft. span.

Bridge No. 3

Bridge No. 3 crosses the Thompson River at its mouth. It consists of an 82-ft. girder span at the southerly end, three truss spans of about 152 feet each over the main river, and a 60-ft. girder span at the northerly end. All are of deck construction. The distance between base of rail and low water is approximately 121 feet and the water at flood rises about 64 feet.

The piers are high, but are founded on solid rock almost at the elevation of low water. Only small cofferdams were required and the construction of the foundations involved no particular difficulties.

The height of the structure and flood conditions render the use of false-work dangerous, hence to erect the truss spans it is planned to place with a derrick car four light trusses braced together and lying just below the plane of the lower chords of the main trusses. The trusses, with enough bracing to steady them, will then be erected by the derrick car, which will not leave the adjacent span. As each panel is erected the portion then erected will be hauled or jacked out upon the light temporary trusses until the entire span is in place. This method of erection is novel, but there is no apparent reason why it should not be employed successfully.

Bridge No. 4

Bridge No. 4 crosses the Thompson River where it is comparatively broad and shallow. The structure consists of six light deck truss spans and has a total length of 844 feet. The bed of the river is made up

C. N. P. Railway Bridge No. 10

largely of hard gravel and boulders, therefore the piers were sunk by the pneumatic process.

Span No. 6 was erected on false work in the usual manner, but spans Nos. 5, 4, 3, 2 and 1 were erected successively as cantilevers, each span being carried by the one previously erected. Though the water is shallow, it is too swift to make the use of false work safe, for it would be impracticable to drive piles in the boulders which constitute the river's bottom, and the use of sunken bents is always precarious.

Bridge No. 5

Bridge No. 5 crosses the Thompson River in a narrow gorge, where the depth of water is great, the current is swift, the difference between low and flood water is 32 feet, and the river bottom is too rough and ragged for the use of false work, even if the current would permit it to be employed; therefore the bridge, which consists of one 35-ft. deck-plate girder span, and a single through truss span, 210 feet in length, was erected entirely from one side, the truss span being erected as a cantilever. The foundations are simple and not especially noteworthy.

Bridge No. 6

Bridge No. 6 cross the Thompson River where it is swift but comparatively shallow. It consists of six 90-ft. deck-plate girder spans, resting on concrete piers, which were sunk by the pneumatic process because the river bottom is made up largely of boulders and coarse gravel. The crossing is on a severe skew and on a curve. The girders were erected by means of a derrick car and the construction involved no unusual difficulties.

Bridge No. 7

Bridge No. 7 crosses the Thompson River where it is comparatively shallow, on a skew and on a curve. It has a total length of 1,046 feet between abutments and is made up of twelve 88-ft. deck-plate girder spans, resting on piers sunk by the open dredging process and supported on piles. The structure is shown in one of the illustrations.

Bridge No. 8

Bridge No. 8 crosses the Thompson River on a skew where the river is broad and shallow, the current swift and the bottom somewhat subject to scour. It has a total length of 1,104 feet between abutments and is made up of ten deck-plate girder spans, each about 93 feet long, with an 86-ft. deck-plate girder span at each end. The piers rest on hard, tough clay and are protected from scour by rip-rap. They were sunk through the overlying sand and gravel by the open dredging process.

Bridge No. 9

Bridge No. 9 crosses the Thompson River where it is comparatively broad and shallow. It consists of a 200-ft. through truss span at the easterly end of a group of six deck-plate girder spans, of which five are about 90 and one is 80 feet long, supported on concrete piers sunk by the open dredging process. Where hard material was found at reasonable depth, the piers rest directly upon it, but where there was much sand and gravel, the piers are supported on piles. The crossing is on a skew and on a curve, but the water is shallow and the superstructure will be erected by usual means.

Bridge No. 10

Bridge No. 10 crosses the broad, shallow mouth of the North Thompson River, where it is navigable. The total length of 1,209 feet is made up of thirteen

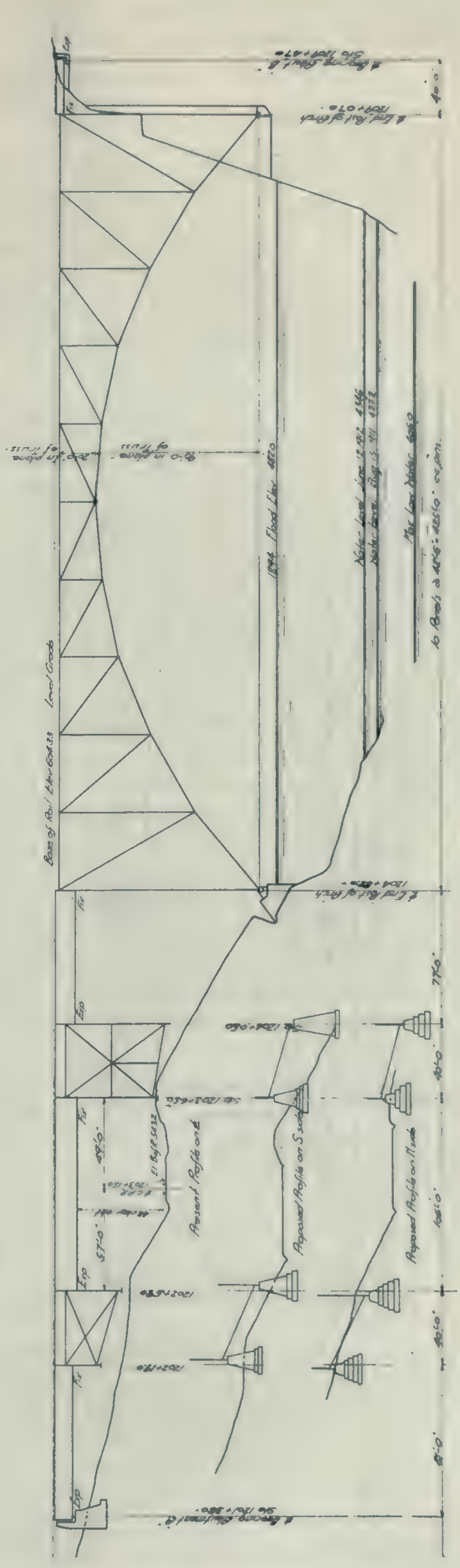


Fig. 1—Elevation of C. N. P. Railway Bridge No. 1, over the Fraser River, near Lytton, B. C.

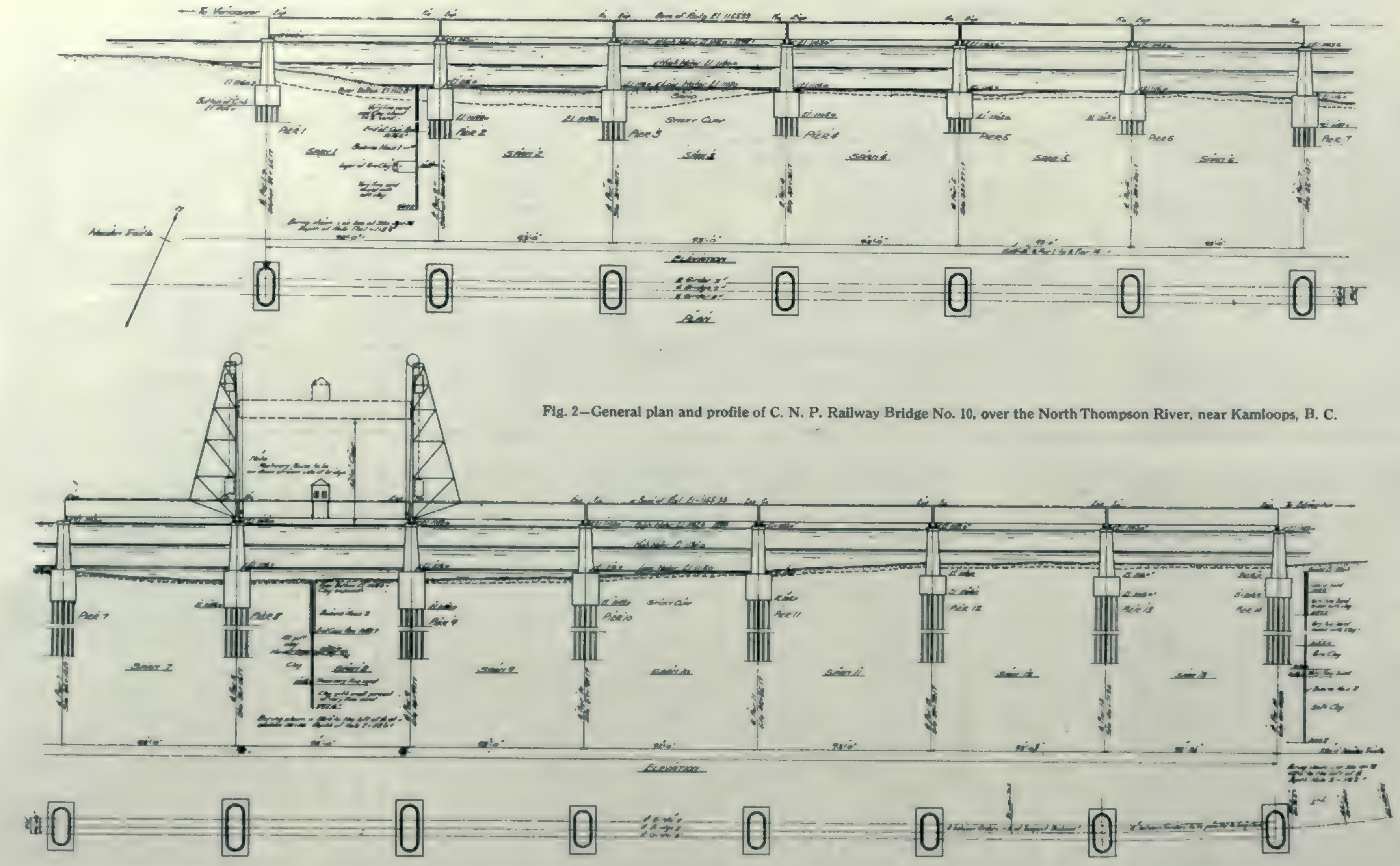


Fig. 2—General plan and profile of C. N. P. Railway Bridge No. 10, over the North Thompson River, near Kamloops, B. C.

The Canadian Northern Pacific Railway Bridges of British Columbia.

deck-plate girder spans, resting on concrete piers. The bed of the river is composed largely of sand and gravel, hence the piers were sunk by the open dredging process and are supported on piles.

To provide for navigation, one of the girder spans is designed to lift vertically to afford a clearance of 55 feet above high water and a horizontal clear opening of about 75 feet. The span is fully counterweighted, hence it is easily raised and lowered by small gasoline engine. As is usual with the vertical lift bridge, the weight of the span and counterweight is transmitted directly to the piers by the front bents of the towers. The back braces which are connected to the adjacent spans, carry wind load only. One of the illustrations affords a view of the bridge ready for service, while the general plan and profile (Fig. 2) are reproduced on the opposite page.

The bridges were designed and their construction was supervised by Messrs. Waddell & Harrington, for Messrs. Mackenzie, Mann & Company under the general direction of Mr. T. G. Holt and Mr. T. H. White, respectively Vice-President and Chief Engineer. The substructures of bridges Nos. 1, 2, 4, 5, 6, 7 and 19 were constructed by Messrs. Armstrong, Morrison & Company, of Vancouver. The contractors for the substructures of Bridge No. 3 were The John Galt Construction Company, of Winnipeg, and for Bridges 8 and 9 The Graff Construction Company, of Seattle. The contractors for the superstructure of Bridges 1, 2, 3, 5, 9 and 10 are The Dominion Bridge Company, of Montreal, and for Bridges Nos. 4, 6, 7, and 8 The Canadian Bridge Company, of Walkerville, Ont. The contractors for the spans and trestles between Yale and Cisco were as follows: substructure, Messrs. Boyles & Company, of Vancouver; fabrication and delivery of metal for superstructures, United States Steel Products Company; erection of superstructures, Messrs. E. E. Davis & Company.

Modern Tendencies in Equipping and Operating Structural Shops

It is essential that the designer, the detailer and the builder thoroughly understand the character of the equipment and the procedure followed in structural steel shops. Unless one is closely connected with the operation of such shops it is difficult for him to appreciate the constant changes in equipment and methods. As the writer has recently visited a number of the leading structural shops in the United States and Canada and has had considerable experience in such shops in the past he will record some of the impressions created.

The greatest progress has been made in the methods and equipment for handling materials, as it is now realized that decreasing the number of operations required to fabricate a member is extremely important. The manner of storing, loading and unloading materials, and the transfer of them to and from the machines are even more important factors than the speeds of the various machines, although the use of high-speed tools has increased considerably. One marked change has been the development of heavy-duty machines for massive work. Shears, bending rolls, straighteners, saws and punches now have much greater capacities. In connection with multiple punches one of the most interesting developments has been the automatic spacing tables in use in some shops. Coincident with the use of heavier machines there is a marked tendency to separate the facilities for light and heavy work. Although this requires a greater floor space, and thus increases the overhead expenses, the increased production has resulted in lower unit costs. The operation of the large-capacity machines for light work is a very wasteful procedure.

Especially in the smaller shops, the use of combination machines, such as machines for shearing and punching, for sawing and rotary planing, for bending and straigthening, etc., has greatly increased. The small combination shearing and punching machines are extremely useful as they can also be taken into the field and used for such emergency service as is unavoidable in erection work. The sawing and rotary planing machines are in some shops displacing friction saws, as the planer face can be used for a number of operations.

Radial extension drills, operating from long arms which may be attached either to the walls or may be swung completely around a column, have come into extensive use. Heavy pneumatic rivetters, carried by a crane which is in turn mounted on a truck, are in use in some shops. The truck runs on a track, and is operated by means of an electric motor. The increasing use of tough alloy steels for the rivet sets has reduced the breakage caused by the punching of thick plates. The increase in the use of large horizontal milling machines is marked. Several of these machines have a travel of from 30 to 40 ft., the plates being held tightly in position by pistons operated from pneumatic cylinders. Rotary planing machines are growing in favor, and duplex adjustable planers are now arranged for planing both ends of long members at the same time. An interesting development has been the milling machines, which have recently come into use for finishing the ends of braces and stiffeners and for chamfering the corners of angle braces. One of these tools is so constructed that it will mill, simultaneously, both ends of two angles. Machines for boring pin holes at both ends of long compression members are also in use, and have been developed to a high degree of efficiency.

Electric drive has now come into almost universal use, and with it there has come more complete pneumatic systems. Most of the larger machines are operated by separate motors, but it is quite common practice to connect several of the smaller machines by shafting, and to operate them from a single motor. Locomotive cranes are being used more and more for yard service and to transport the material to and from storage. The use of magnets suspended from travelling cranes or from the booms of locomotive cranes has effected economy in some plants. Although travelling electric cranes, which span the bays of structural shops, have increased in efficiency and capacity, wall cranes, column cranes and monorail hoists are being used to an increasing extent. The development of monorail systems has been especially marked.

The improvement in the construction of the shops themselves cannot be overlooked. The increasing use of metal frames and sashes has resulted in much better lighting systems, and the ventilation facilities have also greatly improved. In this connection the efficient plant of the St. Lawrence Bridge Company, which was built and equipped expressly for the construction of the new Quebec Bridge, is worthy of note. The large number of special and efficient machines contained in this plant are of particular interest to anyone interested in the fabrication of steelwork. Considering the economic side only, it is hardly probable that the building of such an elaborate plant as this for the construction of a single bridge is justifiable.—Engineering and Contracting.

Modern Bituminous Surfaces and Pavements

By Arthur H. Blanchard[*]

BITUMINOUS pavements have been in use in American municipalities for nearly fifty years, but the introduction of modern bituminous surfaces and bituminous pavements in the construction of highways outside of built-up districts is of comparatively recent origin in America, dating from about 1906. This point is well illustrated by the fact that in 1908 the total yardage of bituminous surfaces and bituminous pavements constructed under the jurisdiction of the eight leading state highway departments in the eastern part of the United States was only 416,700. Since that period the growth of the use of bituminous materials in the construction and maintenance of roads and pavements has been exceedingly rapid.

In order to avoid misunderstandings the various methods of using bituminous materials referred to in this paper will be explained by the following definitions:

Bituminous surfaces are those consisting of superficial coats of bituminous materials with or without the addition of stone or slag chips, gravel, sand or materials of a similar character.

Bituminous macadam pavements are those consisting of broken stone and bituminous materials incorporated together by penetration methods.

Bituminous gravel pavements are those consisting of gravel and bituminous materials incorporated together by penetration methods.

Bituminous concrete pavements are those having a wearing surface composed of stone, gravel, sand, etc., or combinations thereof, and bituminous materials incorporated together by mixing methods.

The definitions of bituminous surfaces and bituminous concrete pavements quoted above have been advocated for adoption in the reports of the special committee on "Bituminous Materials for Road Construction and Standards for Their Test and Use" of the American Society of Civil Engineers, whereas the fundamentals of the above definition of bituminous macadam pavements are embodied in the following quotation from the 1913 Report of the Association for Standardizing Paving Specifications: "If the stone is spread in place and the bituminous cement or binder applied afterwards, the resulting product is bituminous macadam." As sheet asphalt pavements have been in use for many years and as the essentials of good construction have been well established, this type of bituminous pavement will not be dealt with in this paper.

Bituminous Surfaces

Since the formulation of the fundamental principles of the successful construction of tar surfaces by the engineers of the Department of Roads and Bridges of France in 1903, bituminous surfaces have been used extensively in Europe. As an illustration might be cited the construction of five million square yards of tar surfaces in one County of England in 1911, under the supervision of the County Surveyor of Kent, H. P. Maybury, M. Inst. C. E. During the last eight years American engineers have used bituminous materials in this method of construction and maintenance of roads and pavements.

In the case of broken stone and gravel roads, the most efficient method of procedure is to thoroughly clean the surface by sweeping with hand brooms or horse sweepers and hand brooms, the final sweeping being done with bass or other fine fibre brooms. The bituminous material, which is generally heated, is applied to the surface in amounts varying from one-quarter to one-half gallon per square yard, with the aid of pouring cans, hose attached to tanks, hand drawn gravity distributors, horse drawn or motor truck gravity or pressure distributors. Some kind of mineral coating is generally applied to cover the bituminous material. The degree of cleanliness of the surface obtained by sweeping will depend to a large extent upon the details of the original construction. It has been found that a road with a thoroughly rolled and well puddled broken stone wearing surface, composed of road metal from one-inch to two-and-one-half inches in longest dimension, may be easily cleaned and the essential adhesion of the bituminous surface readily secured. This method is characteristic of the modern practice of many of the foremost English and French engineers.

Considerable development has taken place in the use of different kinds of bituminous materials. Tars, both of the water-gas and coal-gas types, continue to be used to a large extent. Without doubt the most comprehensive specifications for the construction of bituminous surfaces with tar are those adopted by the Road Board of England. There has been noted a growing objection to the use of certain asphaltic oils which require from two to three weeks to "set up" to such an extent that tracking will not occur.

Bituminous Macadam and Bituminous Gravel Pavements

Bituminous macadam and bituminous gravel pavements are of many types, one of the primary differences in construction being the use of one or two applications of the bituminous material. The efficacy of many of the types depends upon the combinations of sizes of broken stone or gravel and the combinations of bituminous materials used when two applications are employed. Variations in types also exist dependent upon the manner in which the different courses may be filled and the treatment of the filled course prior to the application of the bituminous material. The one application method is very similar in its simplest form to the construction of a bituminous surface, except that the bituminous material is applied upon a much more open surface. In the case of the two application method in certain instances an attempt is made to build up a two-course pavement, while in others the second application is in reality used as a seal coat.

Two of the main difficulties in the construction of bituminous macadam pavements have been to secure a thoroughly compacted wearing course of non-segregated broken stone and the uniform application of the bituminous cement, so that the broken stones of the wearing surface would be uniformly bound together. In connection with the above statement should be noted the following excerpt from the 1914 Report of the Special Committee of the American Society of Civil Engineers:

---

[*] Professor of Highway Engineering in Columbia University, New York City.

> "An important factor for successful results (in the construction of bituminous pavements by the penetration method) is the thorough compaction by rolling of the road metal before the spreading of the bituminous material."

Two methods which have given satisfactory results will be cited as examples of modern practice.

When the metalling in the wearing course consists of a naturally graded aggregate ranging in size from one-half inch to an inch and one-quarter, it has been found unnecessary to further fill the voids by the application of a finer product before the first application of the bituminous material. The character of the product referred to is shown by the following mechanical analysis:

Percentage passing ½-inch screen	18.9
Percentage passing ¾-inch screen	43.1
Percentage passing 1 -inch screen	34.4
Percentage passing 1¼-inch screen	3.6
	100.0

After the wearing course has been thoroughly rolled, from one and one-quarter to one and three-quarters gallons to the square yard of bituminous material is uniformly distributed. Stone chips, free from dust, are then distributed to fill the surface voids. After the chips are rolled a seal coat of one-half to one gallon per square yard of bituminous material is applied. The pavement is finished by the rolling of a second application of stone chips.

As the second method will be described what the speaker considers the most satisfactory type of bituminous macadam pavement at present constructed in England. The bituminous pavement referred to is known by the name of "Pitchmac" and was designed by the City Engineer of Liverpool, John A. Brodie, M. Inst. C. E. The following description of the standard method employed in Liverpool is given by Mr. Brodie:

> "Pitch grouted macadam has been found to give most satisfactory results in streets of medium and light traffic, and is now being largely used in place of ordinary macadam, and also of more expensive pavements. It is laid to a depth of from 3½ inches to 4½ inches, in two layers. Welsh granite macadam is used, broken to a 2½-inch gauge for the lower layer and to 1½-inch for the top surface. Each layer is put down dry and continually rolled before and after the grouting of pitch and sand mixture has been applied, until the surface is thoroughly consolidated. The foundation is generally of hand-pitched rock, 10 inches deep as for ordinary macadam, but in some cases a bed of 6-inch concrete has been used on main roads. Pitch macadam is also being much used as a surface covering for old boulder pavements, many of which still exist in Liverpool in old streets where the traffic is very small. The cost of pitch macadam may be taken at 1s. (24 cents) per square yard per inch of depth."

Bituminous Concrete Pavements

Bituminous concrete pavements other than sheet asphalt and pavements laid by companies as proprietary articles have received more attention during the past three years than at any time since the days of Abbot, Leverich, Scrimshaw, and Van Camp. Less fear of litigation proceedings and the introduction of economical mixing machines equipped with heating attachments have exerted a marked influence. But, furthermore, the rapidly growing recognition of the inherent advantages of bituminous pavements constructed by the mixing method has been largely instrumental in its adoption for traffic conditions for which it is believed to be economical and suitable. Bituminous concrete pavements, in which broken stone forms an integral part of the mineral aggregate, may be divided into three classes.

It is self-evident that the simplest type is one having a mineral aggregate composed of one product of a crusher, that is, similar to the product, in the usual type of portable crushing and screening plant, which passes over one screen and through the larger holes of the adjacent screen. This broken stone, in certain cases, may be somewhat uniform in size but usually such is not the case. In the speaker's opinion, an essential element in the construction of this type of bituminous concrete pavement consists in using a product of a crusher which will have a range from an inch to an inch and a quarter in its sizes. As an illustration will be cited a mechanical analysis of a product which was obtained from a plant where the broken stone passed over a one-half inch screen and through a one-and-one-quarter-inch screen.

Percentage passing ⅛-inch screen	1.2
Percentage passing ¼-inch screen	4.2
Percentage passing ½-inch screen	34.7
Percentage passing ¾-inch screen	40.6
Percentage passing 1 -inch screen	17.3
Percentage passing 1¼-inch screen	2.0
	100.0

It is apparent that the above product would not be referred to as composed of uniform sized stone. It is of interest to note that certain bituminous concrete pavements, having a width of twenty-five feet, constructed with this product of broken stone in 1911 have been subjected to an average daily mixed traffic of two thousand to three thousand vehicles, and are at present in excellent condition with no maintenance charges to date.

This type of bituminous concrete pavement has been constructed for many years by using either one or, in certain cases, several courses of broken stone mixed with bituminous cement. As an illustration of the latter method will be cited the practice of one large construction company which builds this type of pavement. The first, or bottom course, of metal coated with bituminous cement ranges from one-and-one-quarter inch to two-and-one-half inches; the second course, from one-half inch to one and one-quarter inches; and the third course, from one-quarter inch to one-half inch. The pavement is finished with a dressing of uncoated chips.

Asphalts, tars and tar-asphalt compounds have been used for the bituminous cement. In some cases one kind of bituminous material has been used in the mix and another kind for the seal coat; one of the most common combinations being the use of tar in the mix and asphalt for the seal coat.

As illustrative of some of the details of construction of this type of bituminous concrete pavement which should be covered in contracts, excerpts from specifications recently drafted by Mr. Prevost Hubbard and the speaker for the New York State Department of Efficiency and Economy will be cited. It should be borne in mind that the temperatures and other limitations specified apply to the bituminous cements and mineral aggregate covered in other sections of the specifications.

> "Broken stone for the bituminous concrete shall be heated, as directed, before entering the mixer, to between 66 deg.

C. (150 deg. F.) and 149 deg. C. (300 deg. F.) in revolving dryers in which no flame shall be permitted to come in contact with the broken stone and in which the broken stone shall be continually agitated during the heating.

"The asphalt cement or refined tar shall be heated in kettles so designed as to admit of even heating of the entire mass, with an efficient and positive control of the heat at all times. Asphalt cement shall be heated as directed to a temperature between 135 deg. C. (275 deg. F.) and 177 deg. C. (350 deg. F.). All asphalt cement heated beyond 177 deg. C. (350 deg. F.), either before or during mixing with the broken stone, shall be rejected. Refined tar shall be heated as directed to a temperature between 93 deg. C. (200 dg. F.) and 135 deg. C. (275 deg. F.). All tar heated beyond 135 deg. C. (275 deg. F.), either before or during mixing with the broken stone, shall be rejected.

"When thoroughly heated to the temperature directed, the asphalt cement or refined tar and the broken stone for the bituminous concrete shall be mixed so that the resulting mixture shall contain between five (5) and seven and one-half (7½) per cent. by weight of bifumen as directed. A mixer shall be used, having revolving blades, and so designed and operated as to produce and discharge a thoroughly coated and uniform mixture of non-segregated broken stone and asphalt cement. When discharged, mixtures of asphalt cement and broken stone shall have a temperature not more than 149 deg. C. (300 deg. F.) and not less than 93 deg. C. (200 deg. F.) as directed. When discharged, mixtures of refined tar and broken stone shall have a temperature not more than 121 deg. C. (250 deg. F.) and not less than 66 deg. C. (150 deg. F.), as directed.

"The bituminous concrete, heated and prepared as specified, shall be delivered direct from the mixer to the point of deposition on the foundation in trucks or wagons, provided with canvas covers for retaining the heat. As delivered the bituminous concrete shall have a temperature of at least 66 deg. C. (150 deg. F.). Material having a lower temperature than this shall not be laid upon the foundation.

"Rollers used on the bituminous concrete and the seal coat shall be well balanced, self-propelled, tandem rollers, weighing between ten (10) and twelve (12) tons each. Each shall have a compression under the rear roller of between two hundred (200) and three hundred and fifty (350) pounds per linear inch of roll, and shall be provided with an ash pan, which shall prevent ashes from dropping onto the bituminous concrete or seal coat.

"As soon as possible after the compaction of the bituminous concrete, when the surface is clean and dry, a seal coat of the hot asphalt cement shall be evenly distributed over the bituminous concrete and spread by means of squeeges as directed. The asphalt cement shall be applied at a temperature not less than 135 deg. C. (275 deg. F.), nor more than 177 deg. C. (350 deg. F.), at a rate of one-half (½) to one (1) gallon per square yard, as directed. A thin, uniform layer of dry, clean, No. 1 broken stone (stone chips) shall be immediately spread over the asphalt cement, as directed, by machines or skilled workmen. The spreading of the No. 1 broken stone shall not lag more than twenty (20) feet behind the placing of the asphalt cement coating. Number 1 broken stone shall not be placed on the wearing course before the asphalt cement of the seal coat is applied. The surface of the bituminous concrete shall be kept scrupulously clean until the seal coat is applied, and the contractor shall not permit any hauling over this wearing course before the completion of the seal coat.

"No bituminous concrete shall be mixed or placed between October 1 and May 15, except by written permission, and no bituminous concrete shall be mixed or placed when the air temperature in the shade is below 10 deg. C. (50 deg. F.), or when the foundation is damp or otherwise unsatisfactory."

The second type usually consists of the broken stone composing one product of a crusher and sand or other fine mineral matter mixed together with a bituminous cement. The wearing surface of this mix is sometimes finished by rolling in fine stone chips but generally a seal coat is used together with fine mineral matter for a top dressing. When constructed on a commercial scale, the mineral aggregate is always heated and mixed in a specially constructed machine. Usually the same grade and type of bituminous material is used for the mix and the seal coat.

In the third type of bituminous concrete pavement the composition of the mineral aggregate is definitely covered in properly drawn specifications. As an example may be cited the following method of covering the composition of the mineral aggregate of Warrenite, a proprietary pavement of the Warren Brothers Company, which was used by William H. Connell, Chief of the Bureau of Highways, in drafting specifications for the City of Philadelphia.

"Material passing 1¼-inch screen and retained on No. 2 sieve, 40 to 60 per cent. Material passing No. 2 sieve and retained on No. 4 sieve 10 to 20 per cent. Material passing No. 4 sieve and retained on No. 10 sieve, 10 to 5 per cent. Material passing No. 10 sieve and retained on No. 30 sieve, 10 to 5 per cent. Material passing No. 80 sieve at least 25 per cent. of which will pass a No. 200 sieve, 10 to 5 per cent. The balance, to pass No. 30 sieve and be retained on No. 80 sieve."

The 1914 Specifications of the State of New Jersey contain the following description of the grading of a bituminous concrete pavement similar to the one given above.

Size of Screen	Percentages Minimum	Maximum
Passing 1½-inch and retained on 1-inch	0	15
Passing 1-inch and retained on ½-inch	40	50
Passing ½-inch and retained on ¼-inch	10	25
Passing ¼-inch and retained on a 10-mesh sieve	8	15
Passing 10 and retained on a 30-mesh sieve ...	12	22
Passing 30 and retained an a 80-mesh sieve ...	5	15
Passing 80 and retained on a 200-mesh sieve ..	3	8
Passing a 200-mesh sieve	2	8
Bitumen Content	6.5	8.5

In the construction of all types of bituminous concrete pavements, in addition to the requirements covering the properties of the bituminous cement and the quality and character of the mineral aggregate, certain essential features should be given careful consideration. The following citations from the 1914 Report of the Special Committee of the American Society of Civil Engineers are especially pertinent:

"Where the character of the traffic justifies the use of a bituminous concrete pavement, the same conditions demand an extraordinarily strong foundation therefor.

"The amount of bituminous material to be used in any case will depend upon the peculiar conditions of that case, such as the kind of road metal and of bituminous material, the character of the aggregate, the climatic conditions, etc.

"The character of the mineral aggregate to be used may be controlled by local conditions, but the best results can only be obtained by the use of the best materials. Excessive sizes, or excessive variations in the size of the mineral particles, should be avoided, and the utmost care must be taken to avoid the segregation of the different size particles.

"Mixing machines should be used, and hand-mixing methods should be avoided wherever practicable.

"In the use of a heated aggregate for the construction of a bituminous concrete pavement non-uniformity or excess in the heating of stone should be avoided.

"Where bituminous pavements are laid, the edges should be protected and a sudden transition from the pavement to any softer shoulder material avoided by means of cement concrete or other edgings and such reinforcement of the shoulder material as may be necessary."

Proper Care of Road Machinery

By A. R. Hirst

ROAD machinery is an expensive investment, but doubly so if care is not exercised in its maintenance. If a few simple and inexpensive precautions are observed, it will result in an annual saving of thousands of dollars to the counties.

In the case of rollers, rock crushers and crusher power, which, during operation, are constantly exposed to dust, a liberal supply of oil or grease should be used to flush all bearings and thus prevent the rapid wear resulting from the presence of grit and foreign matter in dry bearings. Good lubrication of all machinery is the first step toward its economical maintenance.

Keep a good supply of extra parts on hand in case of breakage, especially for rock crushers. An extra link for the elevator chain may save many valuable hours. Extra crusher dies should always be on hand.

A tool box equipped with waterproof cover and fastened with a padlock is a necessity. This box should contain, among other things, a good supply of bolts of assorted sizes and lengths, with washers to match; also rivets, screws, nails and spikes. In brief, keep constantly on hand a generous supply of everything likely to be needed in case of a breakdown.

Insist that the roller operator keep his machine clean and in good repair. All grease and dust should be removed from the machine some time before the close of each day's work. A roller that has the appearance of a piece of junk after a single season's work is evidence of inexcusable neglect.

On the larger jobs, a small portable blacksmith's outfit is very useful. With this equipment, rooter and plow points and small tools can be sharpened as often as may be necessary without the delay incident to sending them to a blacksmith. Dull tools make expensive work.

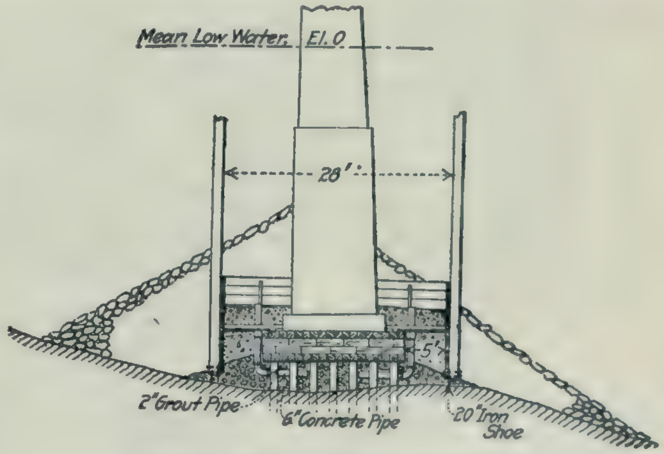
When the season's work is completed, all machinery should be cleaned thoroughly, and a coating of heavy oil applied to all polished surfaces, boiler jackets, shafts, etc., thus preventing rust. Also paint smoke boxes and stacks. Machinery should be stored under cover. It is not necessary that storage sheds have tight sides, but a good roof is essential. It is not the usual practice to keep rock crushers under cover, but if this is done the machine will be in better running order when work is again begun. Rollers, road machines, power engines, wheelers, slips, plows and sprinkling wagons should always be protected during the winter season. Drain all water from all machinery before leaving it.

Sir Thos. Shaughnessy, President of the Canadian Pacific Railway, stated in an interview a few days ago that now was the time for federal and provincial governments to start works of permanent value. Such work would be of much advantage at a time when private corporations were compelled to retrench.

Repairing a Settling Bridge Pier

RATHER an extraordinary case of bridge-pier settlement, which occurred some years ago, has just been reported to the Boston Society of Civil Engineers in a paper read by James W. Rollins, a member of the contracting firm of Holbrook, Cabot & Rollins. The pier in question is Pier 4, the deepest of the pile-footed piers in the Brightman Street bridge at Fall River, Mass., across the Taunton Great River. This bridge is for highway only, has a 50-ft. roadway with two sidewalks of 10 ft. each, and three 200-ft. spans and a rolling-lift span with an opening of 100 ft. Pier 4 is between two 200-ft. spans, each of which weighs approximately 250 tons. It is a prismatic concrete structure 56 ft. high from the top of the pile footing to the top of the concrete masonry.

This pier, in common with two others in the bridge, was founded on timber piles which were driven into and sawed off at the rather hard river bottom, which is from 40 to 45 ft. below water level. The piers were built inside of timber cribs which were sunk to the pile footing by weighting with the masonry which formed the pier. After the pier was completed, the outside forms were removed, but the bottom of the crib, a thickness of 4 ft. in four layers of timber, was left to form a grillage floor between the piles and the masonry.



Repairs to Pier No. 4, Brightman Street Bridge.

The bridge was completed in 1908. About three years later, decided settlement appeared in Pier 4. There was a settlement of about 2 ft. on one side of the pier and a list of 8 to 12 in. away from the side where the greatest settlement occurred. An investigation by divers showed that the broken stone filling which had been placed around the tops of the driven piles had washed out, and that the protruding piles had been broken off all along one side of the pier, allowing the pier to settle. On further investigation, it was found that the piles in this space between the river bottom and the crib had been eaten by the teredo, which is extremely prevalent in the waters of Fall River.

This particular activity of the teredo is, however, most extraordinary, if not unique. The United States Department of Agriculture Forest Service Bulletin, entitled "Preservation of Piling against Marine Wood Borers," says, in respect to the teredo:

> The portion of the pile commonly attacked is between mean low water and a point 4 ft. below, although sometimes it extends downward as far as the pressure of the water will

permit. They seldom work to a depth of over 30 ft., and their worst attack is in very salty, warm clear water.

Mr. Rollins states that the bridge is in Taunton Great River, several miles from the sea and a city sewer discharges into the river within 500 ft. of the bridge, so that the water is not clear nor very salty, yet the teredo works there to a depth of 65 ft. below low water. The particular piles which caused the partial failure of the pier were eaten away at a depth of 45 ft. below low water.

Repairs to the Pier

It was necessary to proceed quite rapidly to the repair because of the condition of the entire bridge. The sinking Pier No. 4 had thrown the spans upon that pier out of line and grade so far as to abut them against the next spans, with the result that a partial arch action was set up clear across the bridge. If the pier had sunk any farther it would probably not only have caused the failure of the spans next adjacent to it but possibly of the entire bridge. For this reason, the span most affected next to the pier was blocked up on a separate pile bent driven under the panel-point next to the pier.

Briefly, the method of repairing the pier was (1) to fill underneath it, that is, in between the protruding piles, with broken stone and gravel shoved in as hard as possible by divers; (2) to construct a framework around the pier with solid board forms about 8 ft. above the broken stone which had been placed under the pier, and to fill within this form with concrete; (3) to grout the stone under the pier and the new crib; and (4) to dump riprap around the pier proper. The methods in detail are described as follows by Mr. Rollins:

> First, 6-in. wrought-iron water pipes 6 ft. long were placed between the crippled piles under the grillage and elbows put on them, with vertical pipes about 8 ft. long fastened to them. A second set of grout pipes 2 in. in diameter were also put in, to make sure that the space between the grillage and the river bed should be made solid. The second operation was to build a form, of 3-in. planks about 8 ft. high, at the bottom of a long timber frame which extended to about 5 ft. above high water. This form was sunk 5 ft. outside the old crib grillage floor, and had an iron plate on the lower edge to provide a seal into the bottom of the river or into the crushed stone which had been placed by divers subsequent to the discovery of the settlement of the pier.
>
> Riprap and crushed stone were then placed outside of this form to steady it and 1:2:3 concrete was deposited through a tremie from the top of the bridge into the space between the grillage and the form. This concrete was made wet to seal the bottom and the crushed stone and was brought up above the top of the grillage all around the pier. This was allowed to set up solid and then a rich concrete, made with 1-in. pebbles, sand and cement, was forced into the 6-in. pipe, but with no success, probably because the concrete deposited outside the grillage under considerable pressure had been forced into all the larger cavities under the grillage. The whole mass was then made solid by forcing grout through the 2-in. pipe until a pressure of 100 lb. per sq. in. would produce no flow.

Finally, a great amount of riprap was deposited all around the pier to a greater height on the weak than on the stronger side. The top of the pier was leveled up, the temporary supporting bent removed and the trusses fixed again on the new pier top.

The work was done under special contract. The total cost without any profit to the contractor, was about $60,000, repair work on Pier 4 alone costing about $25,000.

Compound Piling.—Timber Below, Reinforced Concrete Above, and an Effective Coupling

MANY as are the advantages which attend the use of concrete and reinforced concrete piles, there is a limit to their scope, owing to the circumstance that concrete is attacked by certain kinds of soils and subsoil waters. This is specially the case in marshy or boggy soils, and in subsoil waters containing acids or acid salts, magnesium salts, sulphur compounds or carbonic acid.

Since, then, timber is not attacked in such soils, nor in subsoil waters of the kinds mentioned, and since, in this respect the only proviso is that a timber pile must be permanently under water, we are led to the idea that in such cases where the soil or the subsoil water attacks concrete, we might construct a compound pile with the lower part of timber and the upper part of reinforced concrete. Intimate as is the association of ideas, we are confronted with the practical difficulty as to how two structural materials so dissimilar as timber and reinforced concrete are to be coupled together in a satisfactory manner. The problem has been solved in an effective and yet simple manner as described herein.

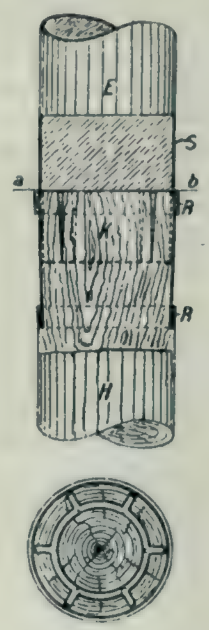


Fig. 1.

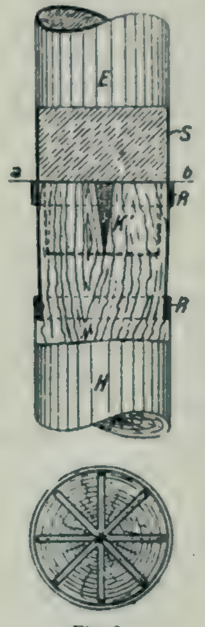


Fig. 2.

The manner in which this compound pile is made is shown in Fig. 1. Before being driven, the timber pile H is made cylindrical at the top, so that a wide binding ring or band can be driven on to it. The timber pile is then driven down until its head is about a metre above the ground or water level. The band is then taken off and a steel tube S, conical in a downward direction, is driven on to the head of the pile by means of a tube head-piece. A ring-wedge, K, is then set upon the head of the pile and is driven into it by means of the ram with suitable dolly. By the driving in of this ring-wedge the originally cylindrical pile-head is forced into the form of a cone, completely filling the conical part of the steel tube, and pressing the pile-head very tightly against the constraint of this shell. When the pile is very hard a conical wedge with radial wedge-ribs may be employed instead of the ring-wedge; and a compound pile constructed in this manner is shown in Figure 2. To avoid the danger of the steel tube changing its shape during the driving in of the ring-wedge, an iron strengthening ring, R, is provided.

By this simple joining of the steel tube and the wooden pile both parts are wedged together, and a tight joint is obtained by the ample pressure between the tube and the wood. When the tube has been made fast on the pile in this manner the pile can be driven into the desired depth by means of a tube head-piece. Then the iron reinforcement is placed inside the tube, and the concrete filled in. The coning of the steel tube may sometimes be omitted, but in this case it must be taken into consideration that the resistance of the cylindrical tube is much less than that of the conical tube, and that a change of shape of the tube at the joint is therefore much more to be feared. For this reason specially stout strengthening rings should be provided. An essential advantage in this method of construction consists in the fact that the pile can be driven with the pile-driver usually employed for timber piles. The costly special pile-drivers necessary for reinforced concrete piles, and the heavy staging necessary in the employment of such pile-drivers are not required. This advantage is specially welcome in the case of pile work in boggy and marshy soils, for in such places the erection of the heavy staging is not only very troublesome, but also involves considerable expense.

A valuable advantage of this compound pile is that it is a very simple matter to place it in position, and that no special precautions need be taken. In the employment of reinforced concrete piles it is necessary to make special arrangements for the assembling of the reinforcement, the setting up of the forms, and the moulding of the piles, for which reason the use of reinforced concrete piling is confined to the larger undertakings. These compound piles will be specially suitable for the carrying out of small works for which, though it is desired to obtain the advantages of reinforced concrete piles, the establishment of a special plant for their erection is avoided on acount of the cost.

The compound pile has a special advantage in sea works. A timber pile standing in sea water will very soon be destroyed by boring shellfish and bore-worms, while, on the other hand, reinforced concrete piles are not seldom attacked by the sea water. By the employment of the compound pile in such a manner that the timber portion is in the ground, and the part which is surrounded by sea water consists of reinforced concrete girt with the iron tube, a very durable pile is provided. The steel tube would, of course, be protected from rusting by a coating or metallic covering, and would be made of a suitable thickness and strength.—The Surveyor.

How to Clean Concrete from a Mixer

Answering this question in the columns of a contemporary, Mr. J. A. McCarty, of Detroit, says it is a better plan to keep the mixer clean, in the following manner:—"One cu. ft. of sharp broken stone should be dumped into the mixer each noon and night, along with clean water. The mixer should run, say 5 minutes, then stone should be dumped out into a box that is equipped with handles, and has plenty of ½ in. holes in the bottom to let the water out. The box can be set aside and the stone will be right there on the job for next cleaning. A mixer that is kept clean will scour very bright in a short time. A brick made of carborundum can be obtained. These bricks easily clean concrete from the sideloader."

Concrete vs. Other Materials for Factories

It is exceedingly difficult to lay down an absolutely definite rule as to the comparative economy of the methods of construction generally adopted for factory buildings. The accompanying figures relate to a case where competitive prices were obtained for a building of fair size and quite suitable to afford a basis for reliable comparison. Alternative schemes were prepared in full detail, and competitive prices obtained. Expressed in percentages, the results were as shown in the table.

Comparative Costs of Factory Construction

1. Steel frame building with brick walls, corrugated iron roof, wood joists and boards on steel bearers to galleries, and patent roof glazing	100%
2. Reinforced concrete building with roof at last	92%
3. Reinforced concrete building with concrete roof, part flat, part with lantern lights, and with brick panel walls	89%
4. Steel frame building, as No. 1, but with corrugated iron walls	89%
5. Reinforced concrete building (no other structural material used)	88%

It cannot be expected that the comparisons here given will apply to all factory buildings. The question of relative cost is affected a good deal by the number of storeys and the size of the structure. In the case of small buildings, reinforced concrete may prove more costly than other materials, although far superior in strength, durability, and freedom from maintenance charges.—Ferro-Concrete.

Field Connections in the Equitable Building

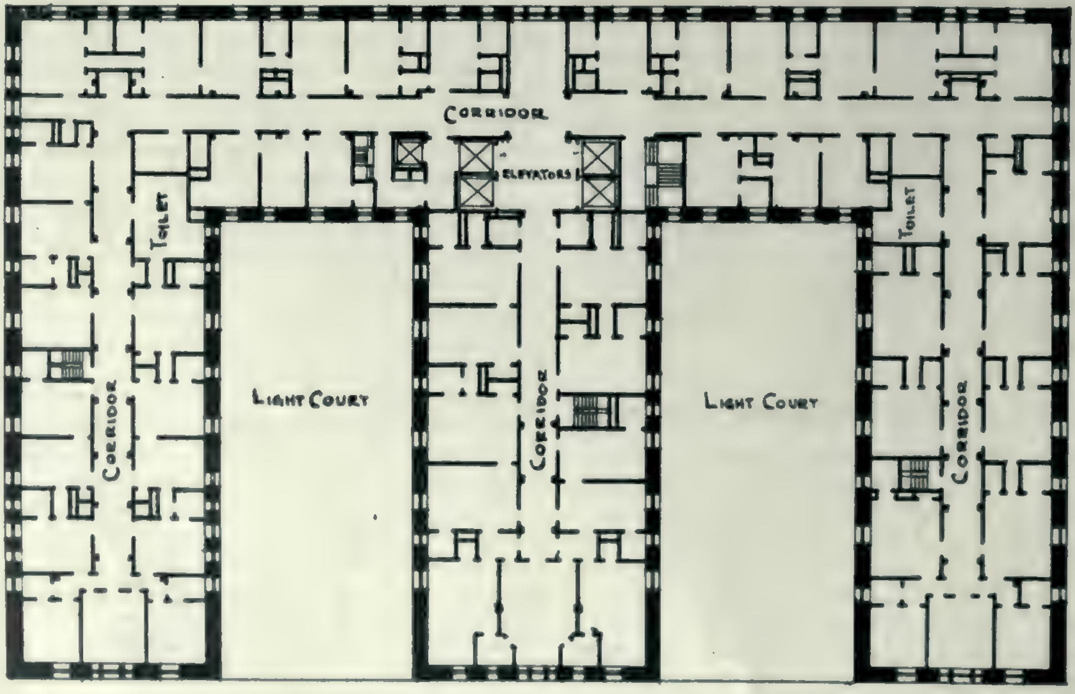
The field connections in the lower seven storeys of the Equitable Building, New York City, are very largely made with 1⅛-in. rivets, of grip up to about 9-in. It has been found that to drive these rivets successfully the largest obtainable pneumatic hammers are required, and air pressures up to 110 lb. must be used. Further, it is important that the point of the rivet be no hotter than the shank under the head, and in some cases the rivets are cooled at the point by dipping into water. In the early stages of the work, a rather heavy percentage of rivets was condemned by the inspector, in some cases because not enough stock had been left for the heading up. As these rivets are now being used, a length of 2⅛-in. is allowed over the grip to form the head and to supply metal for the upset. This allowance is somewhat excessive, but it gives a safe margin to allow for any overrun in the size of hole, etc. Practically all the field-connection holes are reamed out after assembling, in spite of the fact that they are already drilled holes. The reaming insures a perfect match and guards against difficulty in entering the hot rivet. The hammers used are long-stroke Boyer and Ingersoll-Rand 1 13-64 x 8-in. hammers. The experience of the riveting gangs of the Thompson-Starrett Company, as stated by the boss of rivetters, is that about 50 per cent. more ⅞-in. rivets, or about 75 per cent. more ¾-in. rivets could be driven in the time required for a given number of 1⅛-in. rivets. This, as will be seen, means that the 1⅛-in. rivets do not cost more per sq. in. to drive than rivets of smaller size.

C. P. R. station and hotel at Calgary.

The New C.P.R. Hotel Paliser at Calgary

THE C. P. R. have just added another to their list of hotels stretching across the Dominion. This is known as the Paliser, and is situated at Ninth Avenue, Calgary. The plans were by Messrs. E. & W. S. Maxwell, Montreal, and the contractors were Messrs. P. Lyall & Sons Construction Company, Limited, Montreal, Mr. Sanford N. Mapes having charge for the C. P. R.

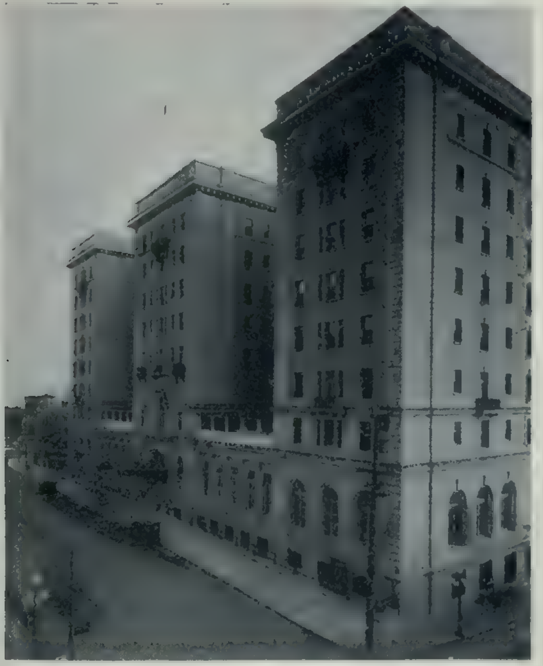
The building, the site of which is 227 ft. x 145 ft., has a basement, ground, mezzanine and seven service floors, with a roof garden and sun parlour on the roof. The architectural style of the exterior is French Rennaisance. Buff pressed brick, of Roman size, is used for the facing of the walls and Indiana limestone for the trimmings. The frame is of steel with reinforced concrete. In shape the building is rectangular as far as the first floor. Above that it is "E" shaped, contained in one wing, 46 ft. wide by 227 ft. long, on the south side, next the railroad tracks, with three projecting wings at right angles on the north or street side.



C.P.R. hotel, Calgary, typical bedroom floor plan.

These wings are 99 feet long, 46 feet wide for the two end ones, and 54 feet wide for the centre one. There are no "inside" rooms. The spaces between the wings afford provision for skylights for the lighting of the lower floor.

The main entrance is on Ninth Avenue, the entrance hall being 46 x 32 feet. The palm room (42 x 50 ft.) is on the left and the drawing room on the right. Beyond is the rotunda, 147 ft. long by 40 ft. wide. The floor of the rotunda, vestibule, entrance hall and elevator hall is of grey Tennessee marble, and the columns supporting the roof are finished in Botticino marble, with Sylvian marble for the bases. On the right of the rotunda is the main dining-room, 38 ft. wide and 142 ft. long, running the whole depth of the ground floor from north to south and finishing in a semi-circular bay at the south end. On the left of the rotunda there are the flower stand, bar and cafe. The bar and the cafe are each 41 x 56 feet. The floors are of 6 x 4 heather brown tiles and the mantel tiles in the cafe are lined with selected Scotch stones. To the north of the rotunda are the elevator hall and kitchen (137 x 41 ft.). Three passenger elevators, one freight, one help, and two electric dumb waiters are provided.



A view of the new C.P.R. hotel at Calgary which illustrates the advantage of the E-shape by which inside rooms are avoided.

The basement, which is reached by stairway from the main entrance, contains the barber shop, baggage room, laundry-receiving room, ten sample rooms, machinery rooms, recreation and sitting rooms for help, bakery, butchery and refrigeration plant. The manager's office, dining-room for officers and help, and musicians' gallery are situated on the mezzanine floor.

The first floor contains a ball room, 48 ft. by 58 ft., situated at the north end of the centre wing. At either side of the ball room, in courts, are pergolas, extending to the side wings. The remainder of this floor, and the whole of the floors above, is occupied by bedrooms, with an average of about fifty to the floor.

The bedrooms range in size from 12 x 15 feet to 20 x 14 feet and are usually in pairs, with connecting doors between and bathrooms on either side. Inside each wing is a broad corridor running down the centre. The bedrooms on the outside of the wings are finished in pale green tints and cream enamel, and those on the inside of the wings in buff and cream enamel. Every bedroom is finished with mahogany doors and a full length of heavy plate glass mirror on the bedroom side of the door. The furniture of the bedroom is fumed oak, with dull brass fittings. There are hot and cold running water, ice water service, telephone, and portable reading lamp, in every bedroom.

The bathrooms are finished in white tile, with ceramic floors and built-in porcelain baths. On every floor is a service room connecting with the kitchen by an electric dumb waiter. Altogether there are 315 guests' bedrooms and 278 bathrooms. The eastern portion of the seventh floor is reserved for help bedrooms.

The heating system in use throughout is direct steam heating with the principal rooms under a system of temperature regulation. Ventilation is secured by large fans drawing in the air through air-filters and washers, and cleaning it of all impurities before being forced into the various rooms through registers at the ceiling. The entire basement and ground floor, with the exception of the dining room, are taken care of by one air-washer, with a capacity of 30,000 cubic feet of fresh air. The dining room has a separate air-washer with a capacity of 25,000 cubic feet. Additional fans are used to draw the air from the rooms and to cause circulation. A refrigerating plant in the basement consists of two ammonia compressors with a capacity of two tons of ice per day.

From the laundry-receiving room in the basement, a tunnel leads to the power house on the south side of the track, on Tenth Avenue—a distance of 490 feet—along which hand trucks with laundry will be conveyed. The power house contains five boilers, which supply the steam heating and power required for the hotel.

The lighting on the street sidewalk is the combination trolley-pole and five-cluster standard. An ornamental iron rail runs the full length of the ground area.

The College of Engineering of the University of Wisconsin are making tests with the object of finding simple means of making concrete watertight. Some of the results obtained so far relate to the effect of the length of time of mixing, and the effects of dry and wet sand, respectively. It has been found that good results are obtained if the concrete remains in the mixer from two to three minutes when dry materials are employed, and that where the sand and gravel or stone are damp a considerably longer time is required. Other experiments showed that mixtures consisting of 1 part of cement, 1½ parts of sand, and 3 parts of gravel, when mixed to a wet consistency, are impervious to water when subjected to a pressure of 40 pounds per square inch. Mixtures as poor as 1 part of cement to 6 parts of well graded sand and gravel have been made impervious at high pressures by using care in proportioning the amount of water and in mixing. The importance of these experiments will be better appreciated when it is remembered that the quality of concrete is dependent largely on the nature and grading of the sand and aggregate.

A Toronto contractor, whose name need not be mentioned, forgot to figure in an item of $710 for labor in making up his tender for the Orde Street school. Consequently his figures were far below those of the next bidder. His application to the Board of Education for the return of his deposit cheque was refused. An expensive oversight!

The Design of Steel and Reinforced Concrete Pillars

FOLLOWING is a summary of a paper read before the London Concrete Institute at the fortieth ordinary general meeting on April 16, 1914, by Mr. Oscar Faber, B.Sc., Assoc. M. Inst. C. E., entitled "The Design of Steel and Reinforced Concrete Pillars, with Special Reference to Secondary and Accidental Stress."

Mr. Faber divided his paper into two sections. He first dealt with jointed construction, such as structural steel, and secondly with monolithic construction, such as reinforced concrete. He first dealt with the case of a girder resting on the end of a steel stanchion and stated that in several drawing offices he knew as a fact that the construction in such a case would be treated as centrally loaded. He proceeded to argue that such was not the case, because when a load was applied to the beam it would deflect and the end originally horizontal would assume a certain slope and therefore one of two things would happen, namely: (a) The end of the girder would lift, in which case the whole load would be carried on one flange, so causing eccentric loading, or, (b) The column must be constrained to adapt itself to the slope of the girder, in which case a bending moment would be introduced into the stanchion by such constraint.

In this way he showed that increases in strains of 140 and 480 per cent. respectively were obtainable.

Mr. Faber took secondly for consideration the case of a girder resting on an angle bracket. He argued that if an ordinary bracket were used the action would not be very far from the face of the leg of the angle, since the horizontal leg of the angle would not be strong enough to resist the bending moment which would be produced in it. It followed therefore that although the horizontal leg of the angle served a useful purpose in connecting the girder to the stanchion, it must not be thought capable of supporting it. In effect the construction became dangerous if the clearing between the face of the stanchion and the edge of the girder exceeded the thickness of the angle.

The author of the paper supposed there were few engineers present who would assert that this limiting clearance was never exceeded in practice, and an engineer had to carefully consider whether it was desirable to employ this type of bracket except for quite small reactions. He next considered a stiffened bracket.

Confining attention to cases where the workmanship was good, he assumed that the stiffening angles had been machined or forged to fit the angle bracket perfectly and that the bracket was initially horizontal. It followed that when the girder deflected there was a tendency for it to rest on the outer edge of the bracket, and for very small loads there was no doubt that this actually happened. As the load increased the outer edge of the stiffeners yielded appreciably, and a greater area supported the load, the reaction gradually approaching the face of the column. The author's practice was to make the web of the stiffeners sufficient in area to carry the reaction under a uniform stress of 7½ tons /in^2.

In calculating the resistance he ignored a large area of steel in the flange of the stiffeners, and in the vertical leg of the angle bracket because,

(a) The clearance between the face of the stanchion and the end of the girder might be sufficient to prevent bearing on this steel;

(b) Even if it was not, this material could not be stressed appreciably until the stiffener webs are greatly overstressed.

In any case the difference in cost between good and bad brackets was an extremely small percentage of the cost of the steelwork, and a smaller one of the cost of the building, and he declined to endanger the "ship" for what in this case might be fairly described as a "ha'porth of tar."

It has long been recognized in good practice that the machining of the ends of stanchions was of the first importance. Yet there were at least two constructional works in London which, with a view to economy, omitted this item of workmanship, and were erecting considerable tonnages of stanchions with the ends left so that the upper tier had contact with the lower tier over the width of one plate only, the remainder of the section having varying clearances often amounting to ⅛ in. The stress was still gaily calculated as uniformly distributed, and it had been explained to the author that "steel is a ductile material which would yield and flow" and perform other convenient antics, "until the stress was uniformly distributed." The effect of loading such a stanchion was to cause the plates to slide past one another, and to partly shear through the rivets. Even where stanchions are machined a careful engineer must bear in mind also that apart from the danger involved in these practices, the yielding of stanchions and brackets before they obtain their bearing involved unknown and unintended stresses on the stonework, and to the author's knowledge many a beautiful and costly facade and interior decorative work had been badly cracked by bad steelwork details and workmanship.

From the consideration of Case I, it would appear to follow that it was desirable to make these joints somewhat flexible, and occasionally this was so. If buildings were braced with diagonal braces he should say without question that stiffness of connections should be avoided. Unfortunately, such bracing had obvious objections, and the whole stiffness of practical buildings against wind lay in the stiffness between beams and stanchions. There was, therefore, no alternative, but to make the joints stiff and to make the necessary allowance for these secondary stresses in the design of stanchions. This might be onerous, both in requiring extra labor and an increase in material, but a conscientious engineer would grudge neither the one or the other.

Mr. Faber then dealt with the design on cleats. A common method of calculating the safe reaction of a cleat was to take it as the sum of the resistances of the rivets, the effect being to neglect the very appreciable stresses due to bending.

Dealing with the bracing of pillars, Mr. Faber said that it was well known that pillars failed by buckling and that their stress was to be determined with reference to their l/g. This phenamenon was fairly well understood and there are sufficient experimental data available to make the design of pillars, with reference to what he might call primary buckling a comparatively simple matter. The phenomenon to which he referred was that of secondary buckling, in which the pillar instead of buckling as a whole, fails by the individual buckling of its component members. On this subject there appeared to be practically no experimental data and practically no formulae or rules for the guidance of a designer. The importance of this problem might be gathered from the fact that bad design in the matter of bracing in pillars was certainly responsible for the two greatest failures in recent years—the Quebec bridge of 1907 and the gas holder in Hamburg.

Mr. Faber then proceeded to the second portion of his paper treating of monolithic construction and the eccentricity of beam reactions on pillars therein. Whereas in steel construction the eccentricity was very definite and easily calculated with most common types of brackets, with reinforced concrete the eccentricity could only be calculated from considerations of elastic flexure, and the problem was a much more difficult one. There was, however, no longer any excuse for claiming ambiguity, since the problem had been analyzed very completely in "Reinforced Concrete Design" and numerical examples fully worked out.

The author took as an example the case of the outside column of the building, working it out in detail, showing very great increases in stress over the values as ordinarily calculated. If thoughts of eccentricity were banished either from ignorance or under stress of competition, the actual maximum stress would have been 1,300 lb. /in². It is interesting to note that the outside pillar in good design did not suffer much reduction in size up through the last three tiers. This was in accordance with the best practice in steel-frame buildings.

In conclusion, Mr. Faber said that without suggesting for a moment that the engineering staffs of several constructional firms were not fully as efficient as many consulting engineers, he did feel that the system of competitive designs and lump prices penalized good designing by such firms, and secured the work to those responsible for the most risky design. The only correct system, in his opinion, was for the architect to entrust the design to an engineer who had his confidence and to invite tenders on the design which he prepared. The architect and building owner were then likely to obtain a sound construction, and if they used their discretion in the choice of the engineer the work would not cost more than the minimum consistent with safety.

The best constructional firms would be protected by being protected from competition with weak design and bad workmanship, and he might state that in considering tenders, he considered that an engineer should give preference to those firms whose detailing and workmanship he knew he could rely upon. He urged this in the interest of the building owner, knowing as he did the importance of good details and good workmanship. The only man to suffer was the man who would take great risks and do shoddier work in order to secure a contract, and he could not say that he had much sympathy with him.

Frost Resistance of Building Stone

THE most reliable sources whence practical results of resistance have been obtained are the signs of weathering in stones under actual building conditions. Where and when circumstances permit, it is best to submit the stone that is to be tested for several years to all the influences of weathering and then decide on the strength of the extent of exfoliation, cracks and rifts exhibited.

The methods of saturating a little cube with a solution of glauber salz and then freezing it is all very well in theory, but in practice there are several objections. In the first instance, the resistance which stone offers to the solution is very different to that offered to water. It is well known that water when freezing expands, and exerts an enormous pressure. Now, through the addition of the glauber salz this very tendency of the water is obviated and in fact reversed, for salt of any kind is conducive to contraction.

Water therefore remains the only reliable means for testing the resistance of stone, but the cubes must not be entirely covered by water, as in that case the air contained in them has no means of escape; they must be slowly immersed, so that the air can gradually escape as it is being replaced by water.

The water is warmed to a temperature of 16 to 20 deg. C. and to ascertain the maximum saturation coefficient of the sample, is weighed before and after saturation. If finally after repeated weighing, the weight remains the same, it is assumed that the maximum point of saturation has been reached.

The samples so saturated are frozen for 5 hours in a temperature of 12 to 15 deg. C., and then thawed again in distilled water under a temperature of + 15 deg. C. This is repeated from 20 to 30 times. To obtain the necessary cold broken ice and freezing salt is used and the samples are then, without being dried, submitted to pressure in order to ascertain their crushing strength when frozen, which is compared with the stone when not frozen serves a basis for the resistance offered by calculating the relative frost resistance.

The lower the difference of the crushing strength before and after freezing, the smaller the exfoliation and the cracks, the greater the frost resistance. At first sight it seems plausible enough, that the frost resistance should increase correspondingly with the decrease in capacity of absorption, and that frost resistance is in an inverse ratio to the porosity of the stone.

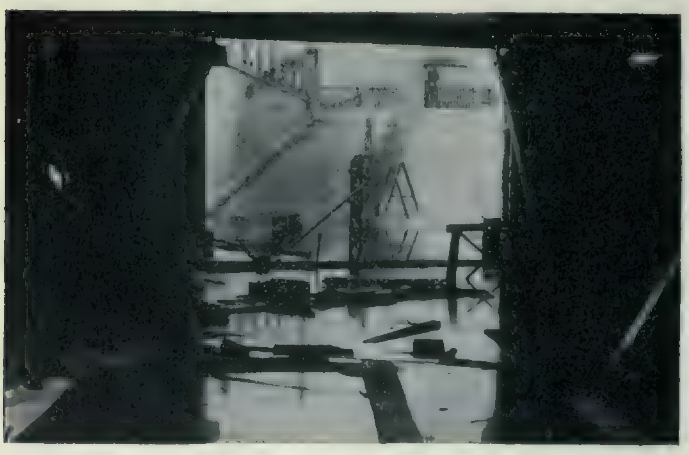
Practical experience, however, proves the opposite. Soft and porous stone is held to be particularly frost-resisting, and hard and brittle stone with few and small pores of but small resistance. The reason, of course, is that with the softer stones the pores give way to the freezing pressure more easily, whereas in the harder ones the constant compact resistance offered conduces to exfoliage, cracks and rifts. The knowledge of the mineralogical components of a stone helps us to ascertain its weather-resisting qualities.

Very harmful additions are principally carbonate of lime, pyrites of iron and gypsum, and most desirable are consequently the most silicious stones.

The great importance attaching to whether or not there is any addition to the water is shown by the fact that basalt, under the influence of water loses 2 per cent. of its dry crushing strength whilst granite loses 8 per cent. It is proved that stone showing a high frost resistance, will also endure against water, but naturally, it must not be assumed that the addition of salt and other materials is superfluous, nor must we over look the necessity of experimenting with the inclusion of various materials of different stone and their composition. The different methods of testing should not replace, but supplement and complete each other.—Stone Trades Journal.

Subway Construction at Vancouver

CONSTRUCTIONAL operations have just been completed at Vancouver in connection with the new pedestrian subway under the Canadian Pacific Railway tracks leading from Alexander Street to the North Vancouver Ferry wharf. The necessity of providing a subway at this point owing to the congestion of pedestrian traffic was first brought to the attention of the Railway Commission in 1910, but it was not until July, 1913, that the detailed plans of the work were finally approved by the engineer of the Commission and the various parties interested therein. The Vancouver civic authorities then proceeded to call for tenders and in due time a contract was awarded to the M. P. Cotton Company, a local firm which later went into liquidation but eventually became re-organized under the title of the Cotton Construction Company, this concern undertaking to handle the various contracts possessed by the former company. The tenders submitted for the work ranged all the way from $30,000 to $50,000, the estimate of the M. P. Cotton Company being the lowest. Actual construction was inaugurated during the latter half of January, 1914, the time consumed until the completion of the work being a little over four months.


Type of construction beneath C.P.R. railway tracks.

South ramp, looking east.

The southerly approach to the subway from Alexander Street extends downward on a 14 per cent. grade and the same grade is observed on ascending to the ferry landing, nine feet of clear headway being provided in the level stretch immediately underneath the Canadian Pacific Railway tracks. Special provision has been made for the hydraulic pressure under the subway floor due to the rise of tide, a head of ten feet being provided for in the design. The floor and walls are constructed strongly enough to withstand this height of water, which, of course, varies according to the rise and fall of the tide. The north and south ramps, about 80 feet in length and 25 feet wide between walls, are of reinforced concrete the floor being of the same construction. The subway proper is approximately 60 feet long and 25 feet wide between walls. The construction of the portion under the Canadian Pacific Railway tracks is in accordance with that company's standard bridge construction and consists of solid concrete abutment walls with roof of rolled steel joints, 20 inches deep and spaced about 15 inches on centres. Rivetted to the top of the steel beams is a ½-inch ballast plate and on top of the ballast plate are three inches of waterproofing asphalt, with nine inches of ballast above that for the railroad ties.

Provision has been made for dealing with any water draining into the subway by the installation of an automatically-operated electric pump with a capacity of 160 gallons a minute and a sump placed at the southwest corner of the north ramp. The water is carried into this sump by means of galvanized iron pipes embedded in the concrete floors which lead from the catch basins to the sump. The pump is of the ordinary automatic electric type with a float which throws the motor into operation by closing the switch when the water rises above a certain height.

During the construction of the subway, the contractors had very little difficulty in coping with the tides. A row of sheet piles were driven at the north end of the works and successfully held back the water during the period of operations below high tide, the tides being favorable at the time this work was under way.

The task of supporting the railway tracks during the construction of the subway was undertaken by the Canadian Pacific Railway engineers and consisted of simply driving four bents of wooden piles between the tracks, capping these and then placing 8 x 18-inch longitudinal timbers beneath the tracks. The penetration of these piles was very small and it was therefore considered necessary, after excavating to a depth of about 10 feet, to substitute 12 x 12-inch mud sills and 12 x 12-inch posts in place of the piles.

The sequence observed during the progress of construction, following excavating operations, consisted of the erection of the reinforced concrete walls on the north and south ramps, the pouring of the southern abutment walls, and the placing of the floors and the two ramps. The floors vary in thickness from 6 inches at the top of the ramps to 20 inches at the base. The extra thickness at the base of the ramps is accounted for by the pressure which has to be sustained on account of tidewater. When the north ramps and abutments had been completed, the steel portion of the subway was proceeded with, the false work removed from underneath the railway tracks and the floor between the abutments poured.

The New St. Charles Hotel, Toronto

Amongst Toronto's many commodious hotels not the least important from the architectural standpoint will be the new St. Charles Hotel now in course of erection on a site on the north-east corner of Bay and Richmond streets, Toronto. The structure, which will be three storeys and basement, has a frontage of 64 feet on Richmond street by 104 feet on Bay street. It will be of steel frame construction, white matt glazed terra cotta being used for the street elevations. The structure, however, will not be of recognized fireproof construction. The three corners of the hotel will be rounded at a 9-foot radius, and entrances will be placed at each corner, access to the building being through revolving doors.

The design of this new hotel has been an effort to obtain as much window space as possible without interfering with the architectural design. The interior will contain the hotel, office and lobby, a large bar and lunch room, with lavatories adjacent. Provision is made for five storeys on the Bay street frontage. On the first floor will be a large dining room, 40 ft. x 60 ft., and three smaller dining rooms together with kitchen and pantry accommodation. The upper floors contain bed rooms, each of which is provided with modern sanitary appliances. The ground floor will be finished in red tile and staff decorations, while the dining-rooms will have oak floors and similar decorations for the walls and ceilings. The building will be steam heated, electrically lighted, and replete with up-to-date hotel equipment. The architect having charge of the work is Mr. J. P. Hynes, Toronto. Thomson Bros., Toronto, are the contractors for excavation, masonry work, etc. The steel construction, a portion of which has already been erected, is being carried out by the firm of Reid & Brown, Toronto. The building will cost about $65,000.

Experimental Pavement of Small Wood Blocks

LAST fall a strip of 100 ft. of experimental paving was put down on one of the residential streets of Tacoma, Wash., using creosoted wood blocks only, 1⅞-in. wide, 2 in. deep and 3⅞ in. long. All blocks were surfaced on one side and one edge to these dimensions, and are of Douglas fir. The blocks were treated in retorts with approximately 18 lb. per cu. ft. of creosote oil. It is in the treatment that the chief advantage is claimed for the small blocks, for excellent penetration without excessive treatment and a uniformity of grain are obtained more easily than with blocks of standard size.

The blocks were laid on a concrete base, 14½ ft. wide, and were laid without an expansion joint of any kind. The pavement was divided into four sections each 25 ft. long, as follows:

(1) Blocks laid with long axis at right angles to the line of traffic on a 1-in. sand cushion; broken joints, blocks rammed tight.

(2) Blocks laid at an angle of 67½ deg. to line of traffic on a 1-in. sand cushion, rammed tight and joints broken as in Section 1.

(3) Blocks laid on a 1-in. cushion made of one part of cement to three parts of fine sand mixed and spread dry; blocks have long axis parallel to the curb, making unbroken joints along the line of traffic; at right angles to the curb joints are broken.

(4) Blocks laid in the same manner as in Section 3, except bedded in a one part cement to three parts sand grout mixed wet enough to take a smooth trowel finish.

An inspection of the pavement some months after it was laid showed water oozing out between the blocks of Section 4, when the blocks were stepped on. The blocks were not perfectly bedded on the grout for there was a perceptible movement of the surface. The other sections were in excellent condition.

The blocks were furnished and laid by the creosoting department of the St. Paul & Tacoma Lumber Company, on their application for permission to do so as a part of an asphalt-paving contract which was under construction. The lumber company gave the city of Tacoma an agreement to replace the blocks with asphalt when so ordered.

Proposed Industrial Building, Calgary

THE city of Calgary proposes to erect a large reinforced concrete building for the housing of new and small industries. This will be the first municipally-owned power building on the continent. Plans have been prepared in the office of the City Engineer, under Mr. H. A. Sylvester, Superintendent of the Department of Buildings. The by-law for the building, which involves the expenditure of $250,000, has been passed by the ratepayers, and the money is available for erection, the site having been selected and the excavation completed.

Sketch of Calgary's proposed Industrial Building.

The plans show a structure with a frontage of 100 feet, the full depth of the lots, and seven storeys high above the basement. The construction throughout will be of reinforced concrete and the building will be provided with every facility necessary for the economic conduct of small industries, besides excellent fire protection and power service. The ground floor will be some 3 ft. 8 in. above the sidewalk grade, and will be mainly given over to entrance facilities and to the freight platforms for the receipt and delivery of goods. A spur track will run into the building next the lane, the storeys above being continued over to gain the additional floor space. The balance of the plot of ground not covered by the building will be utilized for a portion of the freight platform, allowing a team concourse for local deliveries. There will be a total of over 85,000 square feet net in the building for rental, or about 80 per cent. of the gross area, a rather high percentage for a building of this type, where heating plant, elevators, and stairways must be provided generously.

Design and Equipment

A unique feature of the building is the planning of the elevators and toilets, allowing a sub-division of each floor, so that four tenants can have direct access to elevators and toilets without the use of any corridors, and without passing through another tenant's space. There will be two freight elevators of 3,000 lb. capacity, with automatic closing doors, controlled by push-buttons; and one passenger elevator with 6 ft. by 6 ft. 6 in. car. The use of the push-button control for the freight elevators is believed to be unique, in that this control has not before been applied to freight elevators. The platforms for the freight elevators will be 8 ft. by 8 ft. 6 in. On each floor there will be at least four power outlets, besides ample outlets for electric lights. There will be no partitions installed at present except those about the elevator and stairway enclosure, it being planned to use solid steel sash with metal and glazed panels to allow of perfect flexibility and maximum salvage, the partitions being fastened to inserts at top and bottom. In addition to the stairway in the elevator enclosure, there will be two fire-escapes at the opposite corners, one of them being carried down inside the walls, enclosed in a steel sash partition, with wired glass. A complete automatic sprinkler system, with two supplies, will be installed, this necessitating the construction, on the roof columns, of a 20,000-gallon tank. The exterior will be finished in the concrete as it comes from the forms, the only treatment of the surface being rubbing with carborundum blocks. There will be practically 60 per cent. glazed area on the exterior walls, allowing for maximum light and air. The steam heating plant will be a vacuum system, requiring three large boilers of 5,000 sq. ft. radiation each, of the return tubular type, to be fired by natural gas. In addition to the ample toilet facilities required by the local ordinances, drinking fountains will be placed on each floor in the lobby in front of the elevators.

The estimated cost of the building complete is $190,000. As far as can be told at present, the floor space will have to be rented at from 28 cents to 33 cents per square foot net. Power will be supplied from the municipal plant for from 2 cents to 0.9 cents a kw. hour, according to the amount to be taken. Electric light will be sold for 7 cents a kw. hour. There will be about 10,000 square feet net rental area on each floor.

Great Tunnel Project

The North River Bridge and Tunnel Project in New York City is now proposed to be financed by bonding the New Jersey counties adjacent to New York for part of the cost of the structure. The recent New Jersey Legislature passed a law providing for the appointment by New Jersey of a new State Commission, with power to make final preparations and go ahead with construction. A commission is to be appointed by the Governor as soon as at least three of the five counties agree to pay for preliminary expenses up to $10,000 each. The estimated cost of a Hudson River Bridge at 57th Street is $42,000,000, and the cost of two tunnels under the Hudson opposite Canal Street, New York City, at about $11,000,000.

Methodist Book and Publishing House, Toronto

THE new Book and Publishing House which is being erected at Toronto for the Methodist denomination at a cost of about $700,000, possesses several features of interest as regards both design and construction. The site of this new building, on Queen, John and Richmond streets, has been excavated for the main basement, and a steam shovel of the Marion type has been employed in excavating the sub-basement under a portion of the site for the power plant. The floor of this sub-basement will be some 24 ft. below the level of the sidewalk. The building will cover a frontage on Queen street of 135 ft., on John street of 220 ft., and on Richmond street of 190 ft. The structure is planned for an ultimate height of ten storeys and the foundations have been proportioned accordingly. For the present, however, the office portion of the building, with basement, will be five storeys in height and a portion of the manufacturing section on Richmond street will be of two storeys and basement.

The building will be of steel frame construction, the columns resting on concrete caissons or piers, ranging from 5 ft. to 9 ft. in diameter. These caissons are carried down to an average depth of 40 ft. below the level of the street, through blue clay and quicksand to rock. They are proportioned to carry loads ranging from 98 to 159 tons, or a load to each square foot of 25 tons. The floors in the manufacturing section will be of reinforced concrete capable of carrying heavy presses or a load equal to 400 lbs. to the square foot. The floors in the office portion of the structure will be of hollow tile surfaced with terrazzo in the halls, etc., and the office floors will be of hardwood. The entrance to the main office will be finished in marble and mosaic tile. The three fronts will be faced with matt glazed terra cotta of Gothic design, boldly panelled and moulded. This will rest on a granite base 4 ft. in height. The building will be fireproofed throughout and sub-divided into sections with automatic fire doors. Provision is made for seven elevators, the three passenger elevators being high speed.

Methodist Book Room, Toronto.—Filling a caisson with concrete. There are 108 caissons, each averaging 40 feet in depth.

Every provision will be made for handling the work in the mechanical department in the most modern manner and the employees will be furnished with commodious and up-to-date toilet and rest rooms, the sanitary appliances being of the most modern type. The basement will contain large receiving and paper storage rooms, locker rooms and machine and carpenters' shop.

The sectional divisions of the building are classified as follows: the first or main floor will be occupied on the Queen street frontage by five stores and the main office entrance; on the John street side will be stock, entry and shipping rooms, and on the Richmond street frontage the press room, 96 ft. by 188 ft. On the second floor a bindery department will occupy the same area as the press room below, while the rest of the flat will be given over to the wholesale department. On the third floor the Queen street frontage will be occupied by general and private offices and also by a women's lunch room. The central section of this floor will be devoted to the library, stock room and private and departmental offices, while the south section will be occupied by the job printing, proofreaders' and stereotype rooms. The fourth floor is set apart as a boardroom, offices, lunch and rest room, and the linotype department. The fifth floor will be sub-divided mainly for the purpose of rental.

Methodist Book Room, Toronto. Architects' perspective.

The building was designed by Messrs. Burke, Horwood & White, architects, Toronto. The John H. Parker Canadian, Limited, Toronto, are the general contractors, the steel work being carried out by the firm of McGregor & McIntyre, Toronto.

The Pittsburgh & Lake Erie Railway in some new bridge construction at Youngstown, O., specified that no shop paint or oil should be put on. The first paint is applied after erection, scraping the steel clean before painting. The object is to allow the mill scale to loosen by rusting, and thus get the paint applied on the steel itself.

Interesting Construction

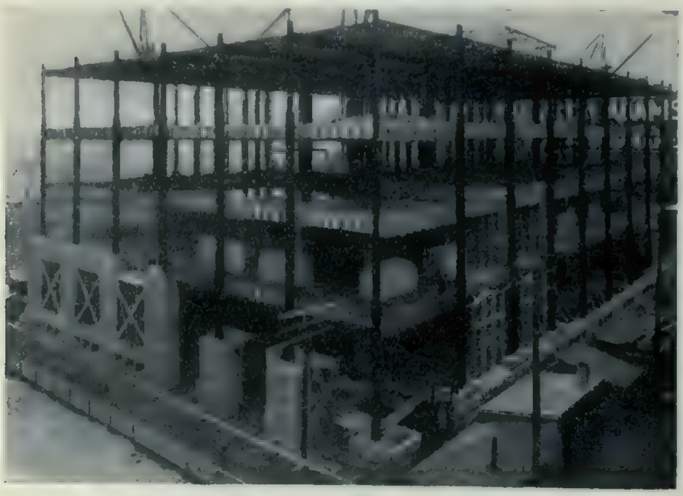
The removal of the two large two-boom timber derrick towers used for erecting the steelwork of the Kingsbridge Armory constitutes quite a task. All the heavy steelwork has been erected so that the big travellers are no longer required. Each is 91 ft. high, 60 x 60 ft. in plan, and is equipped with two separately operated derricks. The framing is all 12 x 12-in. timbers, except the front 14 x 14-in. corner posts, which carry the derricks. In dismantling a traveller one of the derricks on the top lowered the other to the ground. A jinnyswitch was then installed in its place and lowered the second derrick. A ginpole was set on the lower chords of the last two arch trusses and proceeded to take down the framing. When low enough, the traveller was pulled under the trusses to which blocks and falls were fastened. The work then went forward rapidly.

In order to make the Suez Canal of sufficient depth to carry the largest ships afloat, work is now in progress toward deepening the canal to 40 ft. throughout its length, says the Engineering News. When the canal was opened in 1869 the width was 72 ft. and the depth about 26 ft. 2 in. The maximum permissible draft of ships using the canal in 1870 was 24.4 ft. In 1890 ships drawing 25.4 ft. were allowed and during the succeeding 24 years the increase has been at the average rate of about one foot every six years, thus bringing the maximum draft now up to 29 ft. In June, 1913, the depth of 32 ft. 8 in. had been increased over a minimum width of 147 ft. 6 in. for a length of 20 miles. Under the latest scheme, a depth of 40 ft. throughout is to be made and a widening up to 197 ft. in the south section and the cutting of an appropriate number of sidings on the north and central sections where a minimum width of 147 ft. 6 in. is believed to be sufficient. The company has power to raise bonds up to $30,000,000 for this work, which it is expected will be completed by 1919.

Government Examining Warehouse, Calgary

THERE is at present being built at Calgary for the Dominion Government a four-storey building for use as an Examining Warehouse by the Customs Department. The dimensions of the building are 200 by 112 ft., with a frontage of 200 ft. on Eleventh Avenue. The building is of heavy skeleton steel frame construction with reinforced concrete floors and self-supporting walls.

The foundations are carried down far enough to give necessary depth for the basement. The columns rest on steel grillages. The centre grillages consist in the main of seven 15-in. I-beams 8 ft. 6 in. long with four 20-in. I's resting on top of them, and carrying the column directly on top. The wall column grillages are somewhat larger but all varied according to the loads on them. These grillage beams are filled in and grouted with 1:2:4 concrete thoroughly packed in to fill voids and after packing are thoroughly grouted with one to one cement mortar. Owing to the peculiarity of the subsoil, which exists more or less over all the lower lying parts of Calgary, difficulty was experienced with water. When the foundations got below the river bed level, the porous gravel subsoil allowing the easy passage of water, the holes filled up, and pumps run by electricity had to be kept going most of the time to keep the water under control, as the excavation for the grillages, which were below the river level, would fill up over night.

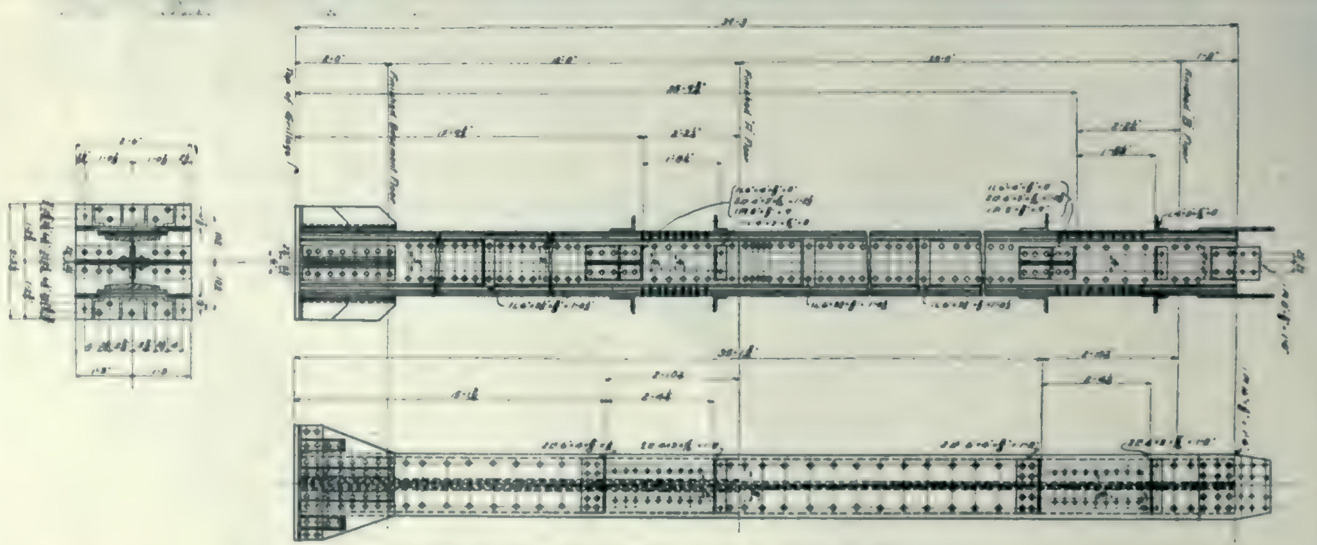


Examining Warehouse, Calgary, under construction.

The steel columns are Bethlehem "H" sections. A typical detail of columns is shown. The steel work carrying the floors consists chiefly of 28 in. x 105 ft. Bethlehem Beams between the columns with 18 in. x 55 ft. intermediate beams spaced about 6 ft. 6 in. apart, the beams all being protected with cinder concrete. The floor slab is 5-in. thick, of 1:2:4 concrete reinforced with .384 of steel per foot and continuous over as many panels as possible. These slabs are designed to carry a load of 450 lb. per sq. ft. under 24-hour test, with deflection not to exceed 1/900 of the span. The slab is not carried on the walls but is carried on 15-in. channels. The present roof is designed to be a future floor on the addition of other storeys. It is of the same strength as the rest of the building and is covered with tar and gravel roofing. The walls are designed to be entirely self-supporting and carry no loads except their own weight.

The structural steel for the building was supplied by The Manitoba Bridge & Iron Works, Limited, Winnipeg. Rapid progress has been made by the contractors, The J. McDiarmid Company, Winnipeg, and it is expected that the building will be completed well within contract time.

Cinder concrete has been put to a new use in Munich, Germany, for lining the exterior walls of the new building of the Duetsches Museum. Its purpose is to serve as insulation and also supply a base which will take nailing, etc. It is not made with ordinary ashes or cinders, but with broken tufa, or porous volcanic rock. With this material a cement concrete is mixed 1:12 or 1:16, and used to form a 5-in. layer on the inner face of the exterior wall, the rest of the wall being stone concrete. This tufa concrete permits nails to be driven in easily, and it can be worked with tools, as was proven by sawing into it at the corner of a door jamb with an ordinary crosscut saw.



Examining Warehouse, Calgary.—Detail of typical column.

Satisfactory Progress at the Coast

Development Work in All Lines Proceeding Steadily—Confidence in the Local Situation Gaining Ground—The More Noteworthy Operations

Office of the Contract Record,
June 5, 1914.

WHILE there is unquestionably a noticeable falling off in the volume of building construction actually under way at Vancouver and the vicinity compared with this time last year, the outlook for the summer months is by no means disheartening; in fact, the amount of work projected both in the coast cities and at points throughout the interior is fairly satisfactory, all things considered. It is true that in common with other Canadian cities Vancouver is feeling the pinch of hard times and for the time being has been forced to curtail building operations to a considerable extent, but it is also a fact that despite the adverse conditions prevailing development work is proceeding steadily at all points and in sufficiently large volume to warrant the greatest confidence in the city's future. Similar conditions are in evidence at other centres of population in this province and everywhere the outlook is regarded with feelings of satisfaction. At Vancouver, building prospects for June are more encouraging than for the previous month, work in connection with a number of important contracts being due to commence during the early part of the month.

Two New Vancouver Hotels

Excavation operations are under way for the foundations of the new seven-storey Blackburn hotel building to be located on Main street, Vancouver, adjoining the present Blackburn Hotel and it is believed that the general contract for the building will be awarded early in June. The construction will comprise a reinforced concrete frame with stone facing on the two lower storeys and a brick exterior for the five succeeding storeys. Provision has been made for one passenger elevator. Messrs. Boyd & Glendenning are the owners of this structure which is expected to cost approximately $100,000. Plans were prepared by Honeyman & Curtis, a Vancouver firm of architects.

It is expected that operations will commence before the middle of June on another large hotel building which is to be erected on Hastings street, Vancouver, near Columbia street, for Mr. A. Clemes, after plans by Mitton & Gillingham. This building will be erected on the site now occupied by the Hasting Rooming House and the general contract will be handled by the J. J. Frantz Construction Company. It will be a combination of steel concrete and mill construction, eight storeys in height with facing of pressed brick. Accommodation will be provided for 120 rooms, most of which will be equipped with private baths. The mechanical equipment includes an oil-burning plant to operate a steam heating system, and furnish power for two elevators, and a vacuum cleaning system. Construction work will involve an outlay of approximately $150,000.

Additional School Contracts Pending

Preliminary sketches of the new Strathcona School which have been prepared by construction superintendent Giles, of the Vancouver School board, show that the proposed building is to be of fireproof construction, probably reinforced concrete, and faced with brick and stone. It will be erected on the site of the old Strathcona School at the corner of Pender street and Jackson avenue and will be two storeys high and measure 218 feet in length, with 24 class rooms capable of accommodating 960 pupils. Only one section of twelve rooms will be undertaken this year, as the amount available for building purposes is not sufficient to cover the entire contract. According to the plans this will be a decidedly attractive structure both as regards interior arrangements and general architectural treatment. It will contain in addition to the usual departments—an auditorium capable of seating 900 with a stage. It is the intention of the School Board to call for tenders without delay in order that the first section of the building may be completed this year. An expenditure of approximately $96,000 has been provided for the work.

Another large Vancouver school upon which work will commence immediately is an eight-roomed two-storey structure for which the B. C. Granitoid and Contracting Company were recently awarded the general contract after plans by Mr. F. J. Giles the constructional superintendent of the School Board. This building will be located in Hastings townsite, at the corner of Twentieth avenue and Clinton street, and will be of reinforced concrete and brick construction with provision for four additional class rooms when required. The figure of the successful tenderers was $58,275.

A contract was recently awarded to Coffin & McLennan covering the construction of a school in the Shaughnessy district, Point Grey, for the Western Residential Schools. The building will be of two storeys, with brick for the lower portion and rough cast and timber work for the top storey. It is estimated to cost approximately $70,000. MacLure & Fox, Vancouver, are the architects.

Other Important Buildings

Operations are proceeding steadily on the site of a two-storey store and office building on Pender street west, Vancouver, adjoining the Dominion Trust Building, for which the Hosking Construction Company was recently awarded the general contract. The construction of this building which measures 52 x 60 feet, will be of tapestry brick, with heavy Flemish bond. All pilasters will have stone caps and keys, and tile and marble will be used for decorating the main entrance. Mahogany is to be employed for interior trim. A steam heating plant will be installed. Plans of the structure were prepared by J. Y. McCarter for the owners, The Western Canada City Properties, Limited, and the cost of construction will reach approximately $25,000.

The Hosking Construction Company is also the contracting firm for the new $40,000 Eagles' Hall Building, Vancouver, upon which an early start is contemplated.

The Dominion Government authorities recently purchased a site in the east end of Vancouver, at the corner of Gore and Keefer streets, on which it is understood that a sub-postal station will be built this year. The property secured has a frontage of 50 feet and extends back 120 feet to a lane. The sum of $125,000 is provided for this project in the estimates recently passed at Ottawa.

Preliminary work has started in connection with the erection of a new branch building at Chilliwack for the Merchants' Bank of Canada. With the exception of the front elevation, which is to be treated in stone, the building will be a substantial brick structure, two storeys in height with full basement. Robt. McLean & Company, Vancouver, are handling the general contract.

The New Westminster contracting firm of Miller & Jewhurst recently secured the contract for a new hotel which is to be built at White Rock for the White Rock Resort Development Company. The building will have a ground floor space of 72 x 96 feet and is estimated to cost about $33,000. In addition to the hotel it is proposed to erect a pier theatre and dance hall at the same location.

A permit was issued recently by the Point Grey building inspector for a fine residence which ex-councillor McSpadden intends to erect at the corner of Granville street and Magee road. This building will be two and a-half storeys in height and will be faced with stone up to the first floor, with rough cast and half timber work for the balance. Shingles will be used for roofing purposes. Oak panelling and hardwood floors throughout are features of the interior construction. The building will contain nine bed-rooms altogether and is likely to cost about $12,000. Mr. H. B. Watson is the architect.

Work has commenced on a two-storey residence of frame construction which is being erected on Belmont avenue, Point Grey, after plans by Parr, McKenzie & Day. This dwelling will be fully equipped throughout and is estimated to cost about $15,000. Mr. James Stables has charge of the contract.

Contract tenders are being invited for the proposed city hall at Port Coquitlam which has been designed by Parr, MacKenzie & Day, Vancouver. The building will be two storeys, of brick construction, with stone trimmings and excellently equipped throughout. Fir is to be employed for all interior finish. A police court and station with police cells will occupy the basement. The cost will be approximately $20,000.

It was considered probable at the end of May that contract tenders would be invited without delay for the new addition to the New Westminster courthouse, a project entailing an expenditure of $60,000. The building will measure 98 x 45 feet and is to be three storeys with full basement. It will be of brick construction with stone trimmings. Accommodation will be provided on the ground floor for the provincial police department, and the first floor will be occupied by a county court room measuring 53 x 34 feet, with offices in connection therewith, while the second floor is to be utilized for a supreme court chamber measuring 53 x 35 feet, grand jury rooms and other apartments. Messrs. Gardner & Mercer, of New Westminster, are the architects.

Nicholson & Cummings, a New Westminster firm of contractors, recently started work on a new office building for the Dominion Trust Company. The structure will be of brick with exterior facing of terra cotta on the front elevation and panelled in the interior with mahogany. The sum of $35,000 has been appropriated for construction work. Plans were prepared by Mr. H. S. Griffith.

Assurances have been forthcoming from official quarters that construction tenders for the proposed post office building at Port Coquitlam will be invited in the near future, plans for the work having been completed by the Dominion Department of Public Works. The structure will be erected at an outlay of about $40,000, half of which amount it is understood, has already been appropriated. A suitable site has been secured in a central part of the city.

Announcement has been made by Mr. G. B. Hull, Resident Engineer for the Dominion Department of Public Works at Prince Rupert, to the effect that plans of the Prince Rupert post office are now ready and that a call for tenders will be issued at an early date. This building will be five storeys and of reinforced concrete construction with brick side walls, and marble facing. The front elevation is decorated with marble columns and provision has been made for four separate entrances. The cost of the building complete will reach about $25,000.

It is believed that tenders will be invited shortly for the proposed new hospital building to be erected at Nelson, after plans by Mr. A. Currie, a local architect. According to the information available, the provincial government has already appropriated half of the $80,000 required for the work. The style of construction to be adopted will probably be reinforced concrete and brick.

Heavy Building Programme on Vancouver Island

A large programme of building construction appears to be in prospect for the present season at various points on Vancouver Island, the main volume of work contemplated being in the neighborhood of Victoria, where the majority of architects report a satisfactory outlook.

Mr. Jesse M. Warren, probably the best known and busiest architect in Victoria at the present time, has completed plans for a two-storey brick and mill construction apartment building to be erected on Yates street, near Quadra street, at a cost of approximately $30,000. This building will contain eleven two and three-room apartments equipped with wall beds and hot water heating. The entrance hall is to be finished in marble and tile. The same architect recently prepared plans for a residence which is to be erected in Victoria for Mr. J. R. Mott at a cost of about $8,000. In this building the front will be entirely of stone and the equipment throughout will be thoroughly up-to-date. Mr. Warren has plans for the following undertakings in course of preparation: warehouse, costing $20,000, to be built at Esquimalt, and a residence, costing $30,000, to be erected in the same district; a $30,000 residence for Dr. J. D. McLean, of Edmonton; an apartment house to cost $27,000.

Plans have been prepared by Mr. Warren for the remodelling of the Harris Block at the corner of Tenth avenue and Main street, Vancouver, for McPherson & Fullerton Bros. of Victoria, the owners. The structure is to be altered from a rooming house to a store and apartment building with 36 two and three-room apartments, at an expenditure of approximately $20,000. The apartments will be fitted with disappearing beds, hot water heating and modern plumbing appliances and the decoration of the main entrance vestibule will be executed in marble and tile.

Cummings & Marcom, a local firm of architects, were recently commissioned to prepare plans for a two-storey apartment building which is to be erected at Esquimalt a suburb of Victoria. This building will be occupied by five stores on the ground floor, the top floor being reserved for the apartments. The same firm have let the contract for a fireproof moving picture theatre at Esquimalt to Dunford & Sons, of Victoria. The structure will have a seating capacity of four hundred persons and will be of brick construction, costing about $7,500.

Although building details are not available at present, it is understood that Mr. J. C. M. Keith has completed plans for the new civic jail which it is proposed to erect on Fisguard street, Victoria, at a cost of about $70,000. Mr. Keith is also the architect for a church building which the congregation of the First Presbyterian Church at Victoria propose to build this summer. Tenders for the excavation of the foundations have been taken and it is believed that a general contract may be awarded at the end of May or beginning of June.

A contract was recently let to Mesher Bros., of Nanaimo, for the construction of a theatre at Cumberland, Vancouver Island, the owners of which are the Cumberland Light & Water Company, Limited. The building has been designed by Mr. E. J. Bresemann, of Victoria, and measures 44 x 126 feet. It will be of frame construction on a concrete basement and its erection will involve an outlay of approximately $25,000. The seating capacity of the ground floor will be for 1,000 persons. The interior finish is to be executed in plaster and Beaver board. Accommodation for a dance hall with hardwood doors will be provided in the basement.

Rapid progress has featured the construction of the new Pantages Theatre on Government street, Victoria, during the last few weeks and the B. C. Construction Company, who are handling the general contract, announce that the building is now about completed. The steel and brick work was erected in record time and the finishing touches to the interior decoration have been executed with great despatch.

Tenders for the general construction of the new Royal Jubilee Hospital at Victoria were being taken at the end of May but some doubt exists as to how much of the building will be proceeded with this summer. It is understood that the erection of the first half of the hospital will occupy a year at least, and involve an outlay of approximately $400,000. This estimate would cover the administration and service buildings and wards with accommodation for 200 beds. Mr Loring P. Rixford, of Victoria, prepared the plans.

The Dominion Public Works Department has plans under way for the new Marine & Fisheries building which is to occupy a site on the Songhees Reserve at Victoria. According to the limited information available, the structure will be fireproof, embodying either brick or concrete construction and will be erected during the summer.

Knott & Jones, a Victoria contracting firm, were recently awarded a general contract covering the erection of the proposed post office building at Port Alberni, Vancouver Island. The building will have a concrete basement, with exterior facing of brick and stone, and will correspond in design with the post office building completed recently at Duncan by Rourke, McDonald & Moncrieff, contractors, of Vancouver. According to the estimate of the Federal authorities, the Port Alberni structure will cost approximately $30,000, this figure being $13,000 less than the expenditure allowed for the Duncan building.

Knott & Jones have secured a contract for the erection of a two-storey church building in Victoria for the St. Columbia Presbyterian Church, the cost of which will approximate $20,000. This will be an eight-roomed structure of frame and brick veneer construction. Mr. W. Henderson prepared the plans.

The Victoria Curling Association propose to erect a $50,000 ice rink this summer in a central locality and plans for the building are now under way by Coates & Fleet, a Victoria architectural firm.

Plans have been prepared by Mr. H. T. Whitehead for two apartment buildings, one to be erected on Government street in the James Bay district and the other on Cook street. The James Bay building will be of brick and mill construction, two storeys high, and will cost about $18,000. The Cook street structure will be of similar construction, but of similar dimensions, and will cost $12,000.

Fort George Anticipates Busy Season

Building construction in the Fort George district promises to be unusually active this season on account of the increased development which it is expected will follow the establishment of regular rail connection over the transcontinental system of the Grand Trunk Pacific completed recently.

The most important contract under way at present is a four-storey hotel which is being erected for Mr. J. A. Brown, of the local firm of Bogue & Brown, by Mr. W. G. Gillette, of Vancouver. This will be a handsome structure measuring 110 x 120 feet, of brick construction for the two lower storeys and timber and rough cast above, resting on a substantial foundation. Accommodation will be provided on each floor for thirty bedrooms, ten of which will have private bathrooms adjoining. The halls, lobby, office, bar and dining-room, will be finished in fir. The mechanical equipment includes an elevator, steam heating apparatus, laundry, pump, electric lighting and plumbing systems. The small power plant will be installed for the purpose of generating the electricity consumed in the building. The probable cost of the building complete will be $125,000.

Mr. W. G. Gillette of Vancouver, has also been awarded the general contract for a theatre which the Prince George Amusement Company proposes to erect without delay at the corner of Third and Vancouver streets, Fort George. This building, plans of which were prepared by Mr. Thos. Hooper, Vancouver, will measure 60 x 110 feet and is to be two storeys in height, with several stores on the ground floor. Seating accommodation will be provided for 650 persons. The construction will be frame with concrete foundation and the cost has been estimated at approximately $15,000.

Mr. J. Payton, a Fort George architect, has prepared plans for a three-storey hotel building costing about $20,000, to be located at that point. This structure will be occupied on the ground floor by four stores and by ninety-two bedrooms in the upper floors. It will measure 60 x 110 feet. The owner's name has not yet been disclosed.

A number of other buildings, principally store structures and dwelling houses, are contemplated for early erection, but details of these are lacking at the moment.

The Morley avenue sewage disposal works at East Toronto were visited recently by an investigating committee of aldermen as a result of the offensive odors emanating from the sludge beds. The committee have suggested that the experts who advised the city on the construction of the plant should be asked to suggest improvements. It is not unlikely that the present system will be replaced by the Imhoff tanks. The latter will probably be adopted for the North Toronto sewage disposal works.

The earnings of Messrs. P. Lyall & Sons Construction Company, Limited, for the year ending March 31 last were $230,405, a decrease of about 11 per cent. on the figures of the previous year. In his presidential report to the shareholders, Mr. Wm. Lyall expressed satisfaction with the general financial situation and spoke optimistically of the prospects for the ensuing year. Mr. Lyall stated that the company were carrying over contracts to the extent of nearly three and one-half million dollars, with the expectation of large additional works to follow.

The "Paraiso," a 15 cu. yd. dipper dredge, twin of the "Gamboa," now at work in Culebra cut, has sailed from New York in tow of a tug. These dredges were constructed by the Staten Island Shipbuilding Company. The dippers are 10 ft. 9½ ins. in height, from the bottom band to the upper edge of the lip, and each has a capacity of 15 cu. yds. They are built with manganese steel lips and dipper-door hinges of forged steel, 6 x 10 ins. in cross-section. They are hung on a 3¼ in. single-part, wire rope hoisting cable. The handle is 72 ft. long with top and bottom bars measuring 2 x 12 ins. in cross-section, and weighs 40½ tons. The dipper boom is 62 ft. long, weighs 66½ tons and is of plate-girder construction. The dredges can dig to a depth of 50 ft. below the surface of the water.

There are $11,000,000 available for railway building in Alberta this year, notwithstanding the alleged hard times. Something like seven hundred miles of new track are to be laid before the snow flies. The province is in an exceptionally good position with regard to the bonding of railways, owing to the fact that the government now has as security for its guarantees several lines in operation which have been profitable since they were opened. Other lines are either constructed between points where operation would be profitable or else very little construction has been done, and the money is still in the possession of the province. If it seems expedient for the government to take over any of these lines at the present time it can do so not only without loss, but actually at a profit—chiefly for the causes stated, that the security of the government is of the best, seeing that the lines are, in part, in profitable operation.

Personal Mention

Mr. H. L. Brown has been appointed Assistant City Engineer of Winnipeg, to succeed the late Mr. R. D. Wilson.

Mr. C. L. Howse, formerly of the Hamilton Hydro-Electric Department, has been appointed Manager of the hydro-electric and waterworks systems of Peterborough, Ont.

Mr. W. R. Worthington, Engineer in Charge of Sewers for the Toronto Works Department, has been appointed District Examiner for the Royal Sanitary Institute of Great Britain.

Mr. W. Hartley Patterson, of the City Engineer's staff at Victoria, B.C., was presented recently with a service of plate by his fellow-employees in that department on the occasion of his marriage.

Mr. Donald A. Andrus

Mr. Donald Andrus, to whom we have pleasure in introducing our readers through the medium of this column, is engineer-in-charge for Messrs. Baldry, Yerburgh & Hutchinson, Limited, contractors for the No. 2 section of the Welland Ship Canal. He received his professional training in London, Eng., and was appointed in 1890 assistant engineer with the Ottoman Railway Company in Asiatic Turkey on the construction of an English line planned originally as the overland route to India, via Bagdad and the Persian Gulf, with terminus at the port of Smyrna. After ten years' service with this company on location and construction, Mr. Andrus proceeded in 1901 to Egypt where British engineers were remodelling and re-organizing the ancient irrigation system of that country, under the guidance of Sir William Willcocks, one of the foremost irrigation engineers of the present day and famed as the designer of the great Assouan Dam on the Nile. Mr. Andrus spent ten years in Egypt on canal construction and other irrigation works. During this period he was engaged for two years on the widening of the Suez Canal. The design and construction of the great undertaking with a section of which Mr. Andrus is now identified was the subject of a detailed article in our issue of March 11, 1914. Mr. Andrus' section, No. 2, comprises four and one-half miles between Port Weller and Thorold and includes locks Nos. 2 and 3. The earthwork which will have to be removed amounts to some 6,500,000 cu. yds. The concrete in the locks has been estimated at 600,000 cu. yds. Preliminary work on Section No. 2 was commenced last December. At the present time Mr. Andrus has three steam shovels and two drag line excavators in operation.

Mr. D. A. Andrus.

Mr. S. G. Strickland, who has just been appointed General Manager of the Chicago and Northwestern Railway, began life as a telegraph operator upon the Canadian Pacific Railway.

The retirement of Major Leonard as National Transcontinental Commissioner is foreshadowed in the introduction of a government bill to empower the Minister of Railways to act in this capacity.

Mr. G. F. Barslow, who has been engaged on location work in this country for the Grand Trunk Pacific Railway, has been appointed District Engineer of the Minnesota Highway Commission, and is now at Stillwater, Minn.

Mr. Bion J. Arnold, whose services were retained in connection with Toronto's transportation problem, has been appointed to a railway terminal commission which will make a comprehensive study of the Chicago terminal problem and report in January next.

Sir Wm. Willcocks, the eminent English engineer, to whom passing reference is made in the note on Mr. Donald Andrus, has been retained by the United States government as consulting engineer to the Reclamation Service. Sir William left last week for Arizona points. He will make a tour of inspection of all the United States reclamation projects.

Mr. Thos. Adams, the English town planning expert retained by the Local Government Board of London, gave an illustrated lecture on town planning at Brantford last week. The meeting was attended by members of the Civic Improvement Committee, the City Council, the Board of Trade and other local bodies.

Mr. C. W. Power, assistant engineer in charge of Railways and Bridges under Works Commissioner Harris, of Toronto, is resigning to accept a position with the Canadian Stewart Company on the Toronto harbor work. Mr. E. G. Hewson, Divisional Engineer of the G. T. R. is named as the possible successor to Mr. Power at the City Hall.

Mr. A. D. Swan, consulting engineer, Montreal, has been retained by the Bristol, (Eng.) Docks Committee to give expert opinion in a law suit regarding harbor construction about to be heard in London. Mr. Swan, who is also consulting engineer to the Vancouver Harbor Commissioners, is to complete negotiations in London for the construction of a large new graving dock at Vancouver, plans of which have already been passed by the Dominion Government.

Necrology

Mr. W. R. Perrin, the well-known Chicago architect who prepared the plans for the civic abattoir in Toronto, died last week. The late Mr. Perrin was born in Indianapolis fifty-four years ago.

Mr. L. L. Gay, a young engineer of much promise, who was specializing in irrigation work, died last month in Montreal. He was born in Vermont in 1879 and was a graduate of the Sheffield Scientific School of Yale University. For several years he was in the United States Reclamation Service, but resigned to accept a position as engineer on a large irrigation project in California. His death resulted from tuberculosis.

Mr. Charles C. Nugent, a civil engineer in the service of the Canadian Pacific Railway for the last seven years, died at Hamilton, Ont., on June 1 from fracture of the skull caused by a fall from his motor cycle when on his way from Hamilton to Toronto. Mr. Nugent, who was a son of Sir Percy Nugent, Bart., Multyfarnham, Ireland, came to Canada seven years ago. He was attached to the Bridge Department of the C. P. R. at Montreal.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

A contract for the construction of brick sewers amounting to $276,000 was awarded last week by the city of Montreal to Alfred Pion, a local contractor.

The Port Arthur armoury, which is costing some $200,000, exclusive of the site, is nearing completion, according to a report received from the contractor, Mr. A. C. Stewart.

A residence, estimated to cost $100,000, is in course of erection at Outremont, Que., for Mr. T. N. Hebert. The architect is Mr. Thos. Daoust, 26 St. James Street, Montreal.

At Quebec City, a church to be known as the Wolfe Memorial Church is to be erected at a cost of $200,000. The architect is Mr. R. A. Cram, of Boston. Plans have not yet been accepted.

For the month of May the Montreal building permits totalled $2,517,148, an increase of $43,450 on the corresponding month last year. The total to date is $6,578,501, a decrease of $1,085,630.

Foundation work is in progress on the new customs house which is to be erected at Fort William, Ont., at a cost of $375,000. The building is to be three storeys high, of concrete and brick construction. The general contractor is M. H. Braden.

The R. C. Cathedral which is being erected at Chicoutimi, Que., at a cost of $300,000 is well advanced and ready for roofing. The building is of stone and steel construction. Mr. R. P. Lemay, Quebec, is the architect, and Mr. J. Giroux the general contractor.

At Montreal, plans have been completed for the erection of a one-million-dollar factory building for Henry Morgan & Company, Limited, a local firm. The building will be ten-storeys high, of reinforced concrete, terra cotta and brick construction. Operations, it is said, will probably be commenced this year.

The construction of a dam across the St. John River at Meductic is proposed by the St. John River Hydro-Electric Company. The project has been laid before the legislature, and its promoters claim the work will cause an ultimate expenditure of some $3,650,000. The proposed dam will cross the St. John at Meductic above Fredericton and transmit power to Fredericton and Marysville, down the valley of the river over 80 miles to St. John.

At Montreal, a comprehensive scheme for improving and beautifying the city has been drawn up by Mr. M. Lavoie, a local engineer who specializes in city planning work, and presented to the Board of Control. The proposed outlay would involve many millions, and the plans involve the construction of several buildings, bridges and boulevards. The centre of the scheme is to be a building close to the present Place Viger station, to be used as a union depot. A ten-storey structure is suggested and the proposal is that it should include a public market, offices and other departments. The carrying out of this scheme would necessitate the moving south of several lines of railroad track. By the building of a bridge across the river and the extension of the Jacques Cartier pier and the Guard pier, Mr. Lavoie is of the opinion that a harbor basin, where all the largest ships dock, could be made completely land-locked in winter.

With the object of co-operating on subjects of mutual interest, the general contractors of Montreal have formed an association and adopted a constitution and by-laws. The organization is in no way antagonistic to similar bodies, but the members are of opinion that they have interests, apart from the various sections of contractors, which warrant the formation of an association. Many of the largest contractors in the city have become members. The officers are:—Mr. J. Penrose Anglin, of Anglins, Limited, president; Mr. E. G. M. Cape, vice-president; Mr. W. Clement Munn, secretary of the Atlas Construction Company, secretary-treasurer; board of directors, Mr. E. Boyer, Laurentian Construction & Engineering Company, Limited; Mr. Donald Ross, of George Ross & Company, Mr. R. Lessard, of T. Lessard & Company, and Mr. Ekin, of the Fuller Construction Company.

At Fort William, an expenditure of some $250,000 has been made on the Superior Brick Company's plant which is now in operation. With satisfactory conditions obtaining this season a successful run of business is anticipated. The plant is situated on the banks of the Kaministiquia River and the C. N. R. spur runs right into the property. The company was organized in 1912 by Mr. A. A. Ayer, president of the A. A. Ayer Company, of Montreal, and formerly a director of the National Brick. Mr. Ayer has some experience in brick enterprises, he having been one of the original promoters of the Laprairie Company, with which he was associated until its absorption by the National Brick. With Mr. Ayer is associated Mr. G. F. Stephens, the paint man, of Winnipeg; Dr. Milton Hersey, Government Analyst, Montreal; Mr. George P. Hartt, Montreal; Senator D. Derbyshire, W. Graham Brown and other eastern men.

The large plant at Varennes, Que., of the Mount Royal Brick Company, Limited, is being put into operation. The company has had a number of serious delays but the plant is now in readiness. Considerable business has already been offering, we understand. During the week, in fact, an order for 12,000,000 bricks has been placed before the company. So far, however, officials have been reluctant to take on a heavy amount of business until confident that the plant was ready to begin manufacture. Discussing the outlook for business this year, a director admitted that there was little prospect of a building boom. Few large buildings were being contracted for. But the demand for residential building was exceedingly good and the orders for the coming season would be for this character of work. Once the plant gets into operation it is highly probable that it will be kept busy for the summer.

WESTERN CANADA

Following the recent letting of the contract for water main construction by the Edmonton Commission Board, an injunction has been applied for to restrain the Mayor and City Clerk from signing contract No. 1 for constructing water mains in the Glenora, Westmount and Delton districts of Edmonton. In the application for injunction partiality is alleged in the awarding of the contracts, Messrs. Graham & McMahon having been given the contract notwithstanding that their tender was not the lowest, and that the bid of Mr. C. L. DeValle was $11,000 lower than any of the other tenders. The City Engineer's reason for not recommending the award of the contract to the lowest tender in this instance was due to a difference of opinion regarding the method of trench digging proposed by the DeValle Company.

The National Paving & Construction Company, Winnipeg, have a contract for paving at Assiniboia, Man., running into more than $166,000.

Messrs. R. J. Lecky Company, Limited, Regina, Sask., have the contract for the courthouse to be erected at Swift Current, Sask., at a cost of $103,000.

Regina building permits for the five months of the present year ending May 31 total $1,179,970, as compared with $1,915,135 for the corresponding period of 1913.

The Winnipeg Athletic Club have selected a site for a 16-storey, fireproof building estimated to cost $750,000. Messrs. Pratt & Ross (Electric Railway Chambers, Winnipeg) are the architects.

Building operations have commenced on the new hotel at Fort George, B.C. The estimated cost is $125,000. Mr. Herbert Peyton is the architect, and Mr. W. G. Gillette, of Vancouver, the general contractor.

The Vancouver building permits last month totalled in value $524,380, the total for the five months being $1,820,984. The corresponding figures last year were $1,029,657 and $6,209,372. The figures are issued by Mr. S. H. Jarrett, Building Inspector.

At Winnipeg, work has been commenced on the last unit of the Grain Exchange building, the total cost of which will run into half a million dollars. The architects are Messrs. Jordan & Over, and the general contractors Messrs. Carter, Halls, Aldinger & Company, both local firms.

Messrs. Grant, Smith & Company & McDonnell, Limited, Vancouver, B.C., have awarded sub-contracts for wharves and docks at Victoria, amounting to two and one-quarter millions. A large contract for cement goes to the Vancouver Portland Cement Company and the Bamberton Cement Company.

At Vancouver, B.C., operations are to commence shortly on a new hotel for Mr. A. Clemes. The building will be eight storeys high and will cost $150,000. Messrs. Mitton & Gillingham, Vancouver, are the architects, and Messrs. J. J. Frantz Construction Company, Vancouver, the general contractors.

At Edmonton, Alta., building operations have been commenced on the new Central police station which is to be erected for the city at a cost of $250,000. The building is to be of brick and it is being erected by day labor under the City Construction Department. The architect for the city is Mr. A. Jeffers.

A bill to amend the Dry Docks Act was given a third reading in the federal parliament on May 22. If passed it will make possible the construction of a dry dock at Vancouver by increasing the rate of interest the government will pay for a period of thirty-three years from 3½ per cent. to 4 per cent.

At Saskatoon, a students' residence in connection with the University of Saskatchewan is to be built at a cost of $104,000. The excavations for the building are now completed. Messrs. Brown & Vallance, of Montreal, are the architects and Messrs. Richardson Builders, Limited, the general contractors.

There are between 300 and 400 men working on the Government interior storage elevators, which are being erected at Moose Jaw, Sask., at a cost of $1,500,000. The capacity of the elevators is to be 3,500,000 bushels and they are being so constructed that this quantity can be readily increased to 20,000,000 bushels.

The normal school at Camrose, Alta., has begun to take definite shape. Good progress has been made in construction and the exterior is nearing completion. The cost is estimated at $145,000. Mr. R. P. Blakey, of Edmonton, is the architect, while the general contractors are Messrs. Read, MacDonald & Brewster, Limited.

Messrs. Claydon Brothers, Winnipeg, are the general contractors for a new school building which is to be erected in that city at a cost of $150,000. The building will be three storeys high, with basement, and will be of stone, brick and reinforced concrete construction. Mr. J. B. Mitchell, architect for the Winnipeg Public School Board, prepared the plans.

The cities of Moose Jaw, Saskatoon and Regina may cooperate with a view to securing natural gas. Since Eugene Coste has withdrawn his proposition, the Saskatchewan cities have been talking of taking united action with a view to drilling for gas in the province of Saskatchewan. The aldermen of the various cities have already talked the matter over informally, but no official action has yet been taken.

E. G. Prior & Company, of Victoria, B.C., have been awarded the contract for all the steel work in the new government piers at the outer wharf, amounting in tonnage to between 6,000 and 7,000, and in value to about $250,000. Each pier is about 1,000 feet long and some 80 feet deep. Another important contract secured by E. G. Prior & Company is the steel work for the new Hudson's Bay Lock at Victoria, which involves about 1,200 tons of steel and an expenditure of $60,-

At Victoria, B.C., operations are proceeding night and day at the site of the Dominion government dock on Burrard Inlet, between Salsbury and Commercial Drives. A drill scow, built specially for the submarine work by the contractors, Messrs. Henry, McFee & McDonald, is moored close to the shore with its battery of five drills. A line of holes has been bored from the outer edge along the western fringe of the wharf site and dredging operations will be started without delay. The Pacific Dredging Company, which has the sub-contract for removing the rock, is commencing operations with one of its largest dredges. The site for the shore portion of the dock is now practically cleared and as soon as sufficient material has been dredged the construction of the foundations for the wharf will begin. More than 200,000 yds., the equivalent of 400,000 tons of rock, will require to be excavated for the foundations.

Suggested Town Planning Scheme for Calgary

An extensive preliminary town planning scheme has been submitted to the city planning commission of Calgary by Thos. Mawson & Sons, the English town planning experts.

The drawings received, although preliminary, are comprehensive. They consist of a plan showing the general scheme within the city limits; a plan of the civic centre and surrounding district, and a perspective drawing showing how this may look many years hence. These are supplemented by sections and elevations in which suggested public buildings are treated in an ideal manner. Numerous plans of the entire city illustrate the adaptability of Mr. Mawson's scheme for fire control; the extension of the car service, the development of a park and boulevard system, the determining of the main traffic routes; the location of new school sites; proposed new factory sites; the enlargement of existing and development of new shopping centres. There is also a plan showing Calgary and surrounding district, on which is indicated proposed automobile roads between the city and surrounding beauty spots. Accompanying the main plans are numerous detail drawings illustrating the suggested treatment of portions of the scheme including plan showing proposed arrangement of workmen's area in east portion of city, a plan of a similar area with details of dwellings in the south portion of the city, and plan of suggested rearrangement of exhibition buildings in Victoria Park. In addition to plans there are various perspective drawings illustrating the possibilities of the scheme with regard to the C. P. R. depot, Centre street, and proposed new market situated on Centre street, south of C. P. R. track; the Centre street bridge, showing alternative scheme of high and low level bridge, the advantages and otherwise of either scheme being dealt with in the report.

The report contains diagrams relating to traffic problems, numerous photos of beauty spots in the vicinity of Calgary, and illustrations for the purpose of comparison with city planning schemes in other cities. Many of these drawings are colored and the perspectives, while they illustrate buildings which are not likely to be erected for a long time, are valuable as illustrating what can be accomplished in the future, it being pointed out that Paris is still working on Hausmann's plans, prepared about eighty years ago and that the city of Boston, has undertaken a scheme which it is intended to spread over a period of 30 years. Chicago has plans which require a period of 100 years for their completion.

Existing conditions in Calgary are considered as they apply to the task of the city planner and the factors which influence the growth and development of the city. Special reference is made to the importance of Calgary as a railway and distributing centre, and its possibilities as a manufacturing centre. Uniform width of streets is condemned as uneconomic, and it is suggested that main traffic routes of considerable width be established, as a result of which the width of paving on residential streets could be greatly reduced. The proposals for street car extensions are arranged so as to make use of practically all existing routes.

The C. N. R. in British Columbia

The construction of the Canadian Northern Railway line in British Columbia from the Yellowhead Pass to tidewater is an undertaking of many difficulties. The Fraser River canyon, which extends from Yale to Lytton, a distance of forty-five miles, is one of the most difficult stretches of railroad construction, as well as being among the most costly. The heaviest mile on this section will cost $326,000. From Yale to Boston Bar, which includes 26 miles of canyon, the rock work was extremely heavy and there are fifteen tunnels aggregating 8,321 feet. The rock is mostly granite and bluff follows bluff, all with practically perpendicular faces, running to about 5,000 feet above the river. Construction was begun from Port Mann to Hope in July, 1910, a little less than four years ago; from Hope to Kamloops in August, 1911; from Kamloops to Birch Island in October, 1911, and from Birch Island to the Yellowhead Pass in May, 1912. The total length of the British Columbia section is 495 miles. In that distance there are only twenty-two miles of adverse grade. Grading has been completed almost the entire stretch through this province, while steel has been laid on about three-fourths of the entire distance. Several big steel bridges have to be completed, this work being done by the Dominion Bridge Company, of Montreal. The bridge across the Fraser at Cisco will be 910 feet long, with a central span of 400 feet. This will be finished in less than two months. The Fraser is re-crossed again at Lytton, and three-quarters of a mile farther on the route crosses the mouth of the Thompson River, it being considered less costly to build these two crossings than one large one across the Fraser. Two miles of work at Gladwin's Bluff cost $222,650 each, and stretches at intervals farther East ran into high figures also. On the entire British Columbia sections there are forty-two tunnels and half that number of high steel bridges. The longest bridge is over the North Thompson River, at Kamloops, it being 1,209 feet in length. The longest tunnel is at Kamloops Lake, 2,835 feet, while the Yale and "Hole in the Wall" tunnels in the Fraser canyon aggregate 3,874 feet. These facts are quoted to point out the costly nature of the undertaking. The principal contractors have been The Northern Construction Company.

Fibre Asphalt Plant for Toronto

Geo. A. Henderson, of St. Albans, West Virginia, announces that a Canadian company has been organized to manufacture the new pavement "Fibred Asphalt," patented in Canada by Mr. Henderson last December. It is proposed to erect a $20,000 factory in Toronto, where graded hardwood fibre will be impregnated. A test pavement, the first of fibred asphalt in Canada, will be laid in Toronto. The Good Roads Year Book of the American Highway Association publishes the following:

"The invention relates principally to the art of denaturing hard-wood and preserving it in the following manner: A billet of hard-wood is shredded into small particles of uniform lengths of 1½ inches down to wood flour, the flour itself being eliminated from the aggregate by screening. The particles are denatured by the process used by the tannin extract manufacturers, in which process all sap, essence and the more evaporable and deteriable elements in the wood are extracted, the remaining particles being thereby rendered abnormally enlarged and porous. In their subsequently dried and heated condition the wood particles, because of their porosity, are susceptible of impregnation, by absorption, by a non-deteriable, non-evaporating matter—(such as asphalt), in lieu of the sap, etc., removed. The heating of the dried particles to prevent the premature congealing of the molten asphalt before reaching the particles' pores, has also for its object the partial contracting of the enlarged particles. The consequent contraction in the size of the particles' pores correspondingly reduces the amount of asphalt required to completely fill them.

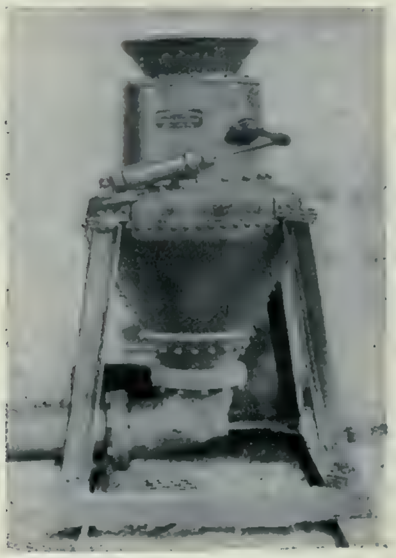
"The wood fibre is a waste product of tannin extract manufacturers, who use hard-wood and no bark in their process. The particles are taken from the leaches on endless belts; dried, screened, heated and then mechanically mixed with a predetermined uniform percentage of asphalt, sufficient to fill the pores and voids in the mass when finally contracted and compressed. The material, in its partially impregnated and partially contracted condition, is deposited at the mouth of its mixer into moulds 4 by 6 feet, these blocks being compressed on all sides only 3 to 4 inches, and allowed to cool, when they will remain intact for shipment, but are readily disintegrated in a breaker stationed at the front of a portable re-heating machine, designed to travel over the road to be paved, in which machine the coated particles are deposited and heated to from 250 to 275 degrees F.

"This heating results in the final contraction of the fibre to its normal size, as it was before being shipped from its original log, and the entrapping of its asphalt content, thereby insuring penetration to the most minute pore of the fibre, thus thoroughly preserving it, without affecting its natural resiliency. The mass emerges from the rear of the re-heating machine in a continuous 18-inch flow onto the previously prepared road base, where it is mechanically spread 4 inches thick, steam roller compression immediately reducing it to a compact mass 2 inches thick.

"Fibred asphalt may be laid on any substantial foundation, such as old macadam, crushed stone, concrete, old brick, granite or wood blocks or cobble stone. For use on country roads a curb or shoulder is not necessary."

Mixing and Placing Concrete by Compressed Air

An interesting method of mixing and placing concrete by the use of compressed air has been attracting the attention of engineers and contractors. The idea is not new, and for some time there have been upon the market machines which utilize air pressure to convey grout through a pipe, or project it against vertical walls for stucco work; but it is only within the last few years that a process has been developed for using air to both mix the materials and convey the concrete to the forms. This method is now well established on a commercial basis, there having been in operation for the last three years machines which handle aggregate of large size and mix and place concrete at the rate of from fifteen to forty yards an hour.



Pneumatic Mixer.
(Pneumatic Concrete Placing Company of Canada)

The mixer consists essentially of an inverted boiler plate cone, standing vertically, having a door in the top for the admission of materials, with a cast steel elbow at the bottom through which the concrete is discharged to the conveyor pipe. The door is operated by a small pneumatic piston, and nozzles are provided for the admission of air into the top of the cone and in the elbow at the bottom of the mixer.

The operation of the mixer is very simple. The aggregate, cement and water in the proper proportions, is admitted through the door, which is then closed; the compressed air, at 80 lbs. pressure, is turned on, and the batch is forced through the pipe, it being mixed as it leaves the mixer and in the first few feet of pipe. Tests on concrete made in this manner show results that are at least as high as concrete made in the ordinary manner.

This method was used to good advantage on the Riverside plant for the Otis Steel Company, at Cleveland. Here the foundations contain about 25,000 cu. yds. The building was located on the flats and the foundations rested on piles. The piers, about 300 in all, averaged 20 feet in height, and the lot—400 by 800, will be filled in with slag and earth. The mixer was located at one side of the lot with its top flush with the ground, and a bin with a capacity of 80 yds. crushed slag and 30 yds. sand was built over it. The bin was loaded from cars or stock pile by a crane, the materials discharging by gravity into a measuring hopper. The cement was placed in this hopper which discharged directly into the mixer. An Ingersol-Rand compressor, of 600 ft. capacity, driven by a 100 h.p. electric motor furnished the necessary air at 80 pounds pressure. An old boiler was used as a storage tank. The pipe used was 8-in. lapweld steel pipe with flanged ends. For the mattresses over the tops of the piles the concrete was discharged through a 45 elbow directly into place. For the piers a goose-neck arrangement was used. This consisted of a vertical pipe, about 20 ft. long, connected at the top to a

Discharging from pneumatic mixer at 200 feet.

horizontal pipe which discharged through a 90 elbow directly into the forms. The whole arrangement was set on a raft and the lower end of the vertical pipe connected by a swivel joint to the pipe main on the ground. This goose-neck could be used to pour two piers by turning the discharge arm on the swivel joint; then the flanges at the bottom disconnected and the entire apparatus rolled to the next two. For moving any distance it could be picked up as a unit, by the locomotive crane, and placed in the new location.

As this job necessitated placing a large number of small units, a small size mixer was used and the average batch was ¼ yard. The mixer force consisted of five men as follows: One man filling sand and stone hopper from bin; one man carrying cement; one man putting cement in measuring hopper; one man operating bottom valve of measuring hopper and putting in the water; one man operating mixer.

The average daily speed for distances up to 600 feet was one batch a minute or 15 cu. yds. an hour. On work involving larger quantities a ½ cu. yd. mixer is used which gives an average of 30 cu. yds. an hour. Where the special nature of the forms made it necessary, two or three men were used at the distributing end. By use of small open chutes the concrete was placed where desired.

Otis Steel Company's plant, showing gooseneck on conveyor pipe.

The contractor for this work was P. T. McCourt, of Cleveland, and the work was under the supervision of Mr. Bowman, Chief Building Inspector for the Otis Steel Company. The pneumatic equipment was installed by the Pneumatic Concrete Placing Company, 45 Broadway, New York.

An economical application of this method is in tunnel lining. A portable plant is at present in operation on the Chicago, Burlington and Quincy Railway, for lining a tunnel where the concrete has to be placed without disturbing the traffic. The plant is self-contained and consists of a Pneumatic Mixer and Conveyor mounted on a flat car with material bins, cement storage, and water tanks. A standard 40-ft. flat car is used, and material bins which slope to the centre are built on each end. Cement and water storage is provided under the slope of the bins. The aggregate, which, in this case, is bank run gravel, runs from the bins into a measuring hopper, into which the required amount of cement is placed. This hopper is raised and dumped into the mixer by a cable operated by a small air piston. The compressed air main is laid through the tunnel and connection can be made to the car at any point. The bins, which hold enough material for 25 cu. yds. of concrete, are loaded, and the car is run into the tunnel and connected to the air line. The mixing and placing of this 25 yards takes one hour and the operating crew consists of four men: One operating bin gates to measure the materials; one carrying cement; one dumping cement into the measuring hopper; one operating the mixer and all valves. This car was equipped for the railroad by the Concrete Mixing and Placing Company, 123 W. Madison Street, Chicago.

While many engineers were at first quite doubtful as to the quality of the concrete made by this method, the results of many tests have proven that this concrete is equal to the best concrete made by the ordinary methods. The fact that the water is in contact with the cement for a few seconds only, and that the movement through the pipe continues the mixing process and allows no separation of ingredients, may account for the excellent quality of concrete obtained.

This machine is patented, the Canadian rights being held by The Pneumatic Concrete Placing Company of Canada, 1014 Transportation Building, Montreal, who have recently commenced leasing these mixers in Canada and who state that several plants will be in operation shortly.

Coming Events

The American Society of Engineering Contractors will hold its midsummer convention July 3-4, at Brighton Beach, New York. The Secretary is Mr. J. R. Wemlinger, 11 Broadway, New York.

The annual meeting of the American Society of Testing Materials is to be held June 30-July 4 at Atlantic City. Professor Marburg, of the University of Pennsylvania, Philadelphia, is the Secretary.

Plans for the Eleventh Annual Convention and the Sixth Annual Good Roads Show to be held in connection therewith were discussed at a special meeting of the Board of Directors of the American Road Builders' Association held in Montreal on May 20th. This meeting had been called owing to the attendance of a large number of the directors of the Association at the First Canadian and International Good Roads Congress. The programme covering the Annual Convention and Show is now being prepared and the list of speakers will include the men who are known the country over as the leading experts in their respective lines. The first Good Roads Show was that given under the auspices of the A. R. B. A., and the show this year in Chicago will be the largest and most elaborate ever attempted. It will be participated in by a much larger number of exhibitors than have ever taken part in a similar show, and the Executive Committee are now working on plans calculated to make it most instructive from an educational point of view. A large number of the states will make exhibits, consisting of testing apparatus, constructional methods and so on. Assurances are given that the leading cities will make creditable exhibits.

Announcement is made that the United States Steel Corporation and its subsidiary companies propose to have a comprehensive exhibit of its operations at the Panama-Pacific Exposition in San Francisco in the year 1915. The exhibit will begin with the ore fields and carry on an educative picture of the firm's operations in ore mining, rail and water transportation, dock operations, coal, coke and pig iron production, and steel manufacturing in its various lines.

In a note regarding the Nova Scotia Construction Company, published on page 683 of our issue of May 27, the number of concrete piles driven in connection with the firm's contract for the government pier at the north end of Halifax harbor should have been 1,600, instead 160,000, as was reported owing to an unfortunate typographical error. Some 1,900 piles in all will be driven. The cost of the work is in the neighborhood of $1,000,000.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Brock, Sask.

The village council has under consideration the construction of sidewalks and the purchase of road machinery.

Battleford, Sask.

The construction of waterworks is proposed by the town council. Permission has been granted by the Provincial Government to raise the sum of $30,000.

Brampton, Ont.

The town council has given authority to the water commission to start work on the new water main on Queen St.

Calgary, Alta.

Tenders will be received by the City Commissioners until 1 p.m., June 24th, for the supply and delivery and duty paid at Calgary of 100 1-in., 50 ¾-in. and 20 2-in. water meters, positive frost proof case or bottom. Engineer, A. W. E. Fawkes, City Hall.

Ford City, Ont.

Tenders will be received by the engineer, Owen McKay, Walkerville, who has plans and specifications, until June 18th, for the construction of 4,000 ft. brick and arch sewers, with catch basins and lot connections.

Fredericton, N.B.

The municipal council has under consideration the construction of 4 blocks of tarvia pavement. The work will be done during the summer.

Mortlach, Sask.

The construction of roadway is being considered by Wheatlan's Rural Municipality. Sec.-treas., G. F. Cliff, Mortlach.

Medicine Hat, Alta.

The city council has decided to construct concrete sidewalks under the supervision of the engineer, A. K. Grimmer.

Montreal, Que., St. Lambert

Plans for the laying of about 25,000 to 30,000 lin. ft. concrete sidewalk and curb and sidewalk curb and gutter, are at the office of the engineer, E. Drinkwater, who will receive tenders until 6 p.m. June 15th.

Ottawa, Ont.

Plans for the following paving have been drawn by the city council. Tarvia pavement on Carling St., tarvia surface 2,985 sq. yds., curb and gutter 965 lin. ft., gutter 965 lin. ft., cost $6,796; wood block pavement on Clarence St., between Anglesea Sq. and St. Patrick St., wood block 2,107 sq. yds., curb and gutter 30 lin. ft., gutter 1.015 lin. ft., headers 105 llin. ft. gutter 1,015 lin. ft., headers 105 on O'Connor St., between Laurier and Lewis Sts., asphalt 7,800 sq. yds., curb and gutter 3,633 lin ft., gutter 30 lin. ft., headers 272 lin. ft., cost $28,000; York St., wood block pavement 5,896 sq. yds., curb and gutter 1,190 lin. ft., gutter 3,009 lin. ft., headers 82 lin. ft., cost $28,800; Broad St., asphalt 3,166 sq. yds., stone blocks 2,122 sq. yds., curb and gutter 880 lin. ft., gutter 1,087 lin. ft., headers 200 lin. ft., cost $22,656; Stirling St., asphalt 3,246 sq. yds., gutter 2,741 lin. ft., headers 131 lin. ft., cost $12,290; Tormey St., macadam tarvia finish between Charlotte and Coburg Sts., macadam 1,250 sq. yds., gutter 800 lin. ft., headers 30 lin. ft., cost $2,662.

The following paving is also proposed by the city council. Asphalt pavement on Kent St., between Wellington and Catherine Sts.; asphalt pavement on St. Joseph St., from St. Patrick St. to the end of the street; pavement on Monk St., between 5th Ave. and Wilton Cres., the material has not yet been decided upon.

The city council proposes to purchase a trench rammer, worked either by steam or gasoline.

Rocky Mountain Park, Alta.

Tenders will be received by W. W. Cory, Dept. of the Interior, Ottawa, until noon, June 17th, for the construction of (a) No. 2 Section of Banff Castle Highway from Station No. 170 x 00 to Station 504 x 00; (b) No. 4 Section of Castle Vermilion Highway from Station 120 x 00 to Station 478 x 60. Plans and specifications are at the office of the Commissioners of Dominion Parks, Ottawa, Ont. Chief Supt. of Dominion Parks, Edmonton and Supt. of Rocky Mountain Park, Banff, Alta.

Rosetown, Sask.

The Fairview Rural Municipality No. 258 propose to expend the sum of $5,000 on road improvements.

Redcliff, Alta.

By-laws authorizing extensions to the waterworks and electric lighting systems, at a cost of $90,000, have been carried by the ratepayers.

Sault Ste. Marie, Ont.

Tenders addressed to the Mayor will be received by the city clerk, C. J. Pim, until 5 p.m. June 15th, for the construction of about 12,000 sq. yds., concrete pavement, 1,800 sq. yds., vitrified brick pavement, 20,000 sq. yds., asphaltic concrete or bitulithic pavement, 5,000 sq. yds., "Dolarway" or pavement with similar top dressing, 1,400 sq. yds., hard stone blocks or hillside vitrified brick pavement. Specifications are at the office of the engineer, W. W. VanEvery.

The town council proposes to construct permanent pavements on a large number of streets.

Toronto, Ont.

The following public work is recommended by the Commissioner of Works, R. C. Harris: cement concrete sidewalks, $52,305; concrete pavements, $217,985; asphalt, $63,705; bitulithic, $25,166; brick block, $10,381; tile pipe sewers, $39,917.

The Board of Control propose to lay a plank roadway on Bloor street from high Park Ave. to Keele street to facilitate operation of motor bus line from West Toronto to Roncesvalles and Boustead Aves.

The Scarboro township council has filed an application with the Railway Board to compel the Canadian Northern Railway Company to construct the subway on Dawes Rd.

New Toronto, Ont.

Tenders close with the town clerk, G D. Scott, on June 12th, for the supply and laying of cast iron water mains, valves, hydrants, etc., steel water tank, also the supply of steel intake pipe.

Wawota, Sask.

The Walpole Municipality No. 92 has been authorized by the Provincial Government to raise the sum of $6,000 for road construction.

CONTRACTS AWARDED

Amherst, N.S.

The town council has awarded to J. N. Fage, 72 Havelock St., and J. E. Lusby, 59 Lr. Victoria St., the contract for concrete pavement, at $1.98 per sq. yd., sidewalks on 4 streets, 3,849 sq. yds., at $1.22 per sq. yd. The Canada Cement Company will supply the chief ingredients for paving. The contractors propose to purchase a Batch concrete mixer to be run by gas engine.

Assiniboia, Man.

The municipal council has awarded to the National Paving & Constr. Company, of Winnipeg, the contract for the construction of paving from the Winnipeg city limits to Headingly, a distance of 5½ miles.

Brampton, Ont.

A contract for the construction of concrete sidewalks on various streets has been awarded by the town council to Wm. Rowe, Mill St., at 67½c per ft. Material will be supplied by the town.

Jarvis, Ont.

The village council has awarded to Curran & Clement, of Orillia, the contract for laying 10,624 sq. yds. concrete, at $1.40 per sq. yd.

Kamsack, Sask.

The following contracts have been awarded by the town council. L. U. Schruth (A) labor for laying watermains and sewers, (R) labor and material for construction of concrete reservoir, (T) concrete walk: Dominion Bridge Co., Canada Bldg., Winnipeg, (C) material and erection of water tower, (D) supply of cast iron pipe; Jenkins Bros., of Montreal, (E) fire hydrants and valves: North West Constr. Com-

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.
HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 June 17, 1914 **No. 24**

Principal Contents

British Trade in Canada ... 767
Concerning One-Sided Contracts and Their Fulfilment 768
The Requirements of the Municipal Engineer ... 769
By H. N. Ruttan
Haste in Building ... 769
Foundations, Eccentric and Concentric, and Resulting Soil Pressure ... 770-2
By W. Muir Edwards
An Important Terminal Scheme ... 772
Modern Refuse Disposal Practice at Halifax, N.S. ... 773-4
Concrete Roads vs. Foundations ... 775-8
By Major W. W. Crosby
The Self-Purification and Care of Water Stored for Public Supply Purposes ... 779-81
Separate and Combined Sewers in Their Relation to Sewage Disposal ... 782-4
By John H. Gregory
Possibilities of the Nail-Head as a Decorative Medium 784-5
The Part of the Architect in Structural Engineering 786-7
By W. E. Brown
Why Brick Houses are Cheaper ... 787
Proposed Central School Building, North Vancouver. 788
Strength of Brickwork ... 788-9
Moving Loads on Bridges ... 789
The Modern Architect ... 789
The Bulk Handling of Cement ... 790-1
By H. M. Capron
New Vancouver Club Building ... 792
Personal Mention, and Obituary ... 793
Constructional and Industrial News ... 794-6
Greater Winnipeg Water Supply ... 796

British Trade in Canada

TRADE Extension Over-Seas was the topic of an article published in our issue of August 20 last, in which we considered the conditions under which business between Canada and Great Britain was being carried on. In this article we included among the constructive factors the interchange of visits by responsible business men, a careful reconnaissance of the Canadian field by one of the principals, and the appointment of enterprising, reliable agents. We arrived at the conclusion that there was vast scope for further effort on both sides.

We make this mention of our previous article preparatory to enlarging upon points contained in an address by Mr. C. Hamilton Wickes (H. M. Trade Commissioner in Canada) before the London Chamber of Commerce last month.

It is a matter of gratification to find the outline of trade conditions given by Mr. Wickes, together with his description of the characteristics of the Canadian market, along lines parallel to those upon which our observations were laid down last year.

A matter which received careful attention at the hands of Mr. Wickes is the currency question. On more than one occasion we have deplored the action of British manufacturers in maintaining the practice of sending out catalogues and price lists containing quotations in English currency. This has been a source of much trouble to Canadian business men. In cases, owing to deductions allowed for discount and other charges, they have been obliged to consult the customs authorities on the question of adjustments. It is difficulties such as these that cause the Canadian agent to look upon British agencies with less favor.

Emphasis is given by Mr. Wickes to the objection that Canadians have to waiting two or three months for their goods. This is a point that may well be committed to heart by a number of British firms of our acquaintance, but at the same time there is undoubtedly considerable misconception on this score. It must not be taken for granted that all the advantages of delivery and freight are with the United States firms. Mr. Wickes expresses the opinion that there is little difference in the freight cost or in the actual time taken in delivery between British ports and United States factories to, say, Montreal and western points. We venture to add that often much of the difference that has undoubtedly existed in cases has been due to the lack of that enterprise which the spirit of competition has engendered in our friends across the border.

In regard to the distribution of goods in Canada, which must necessarily be attended with considerable expense, the Commissioner suggests the advisability of manufacturers combining to share the expense of opening up the market. Such co-operation would be especially feasible in the case of manufacturers of similar but non-competitive articles.

No consideration of trade conditions between the two countries would be complete unless special attention were given to the matter of agencies and we are interested to find that Mr. Wickes deals carefully with this subject. In our previous article we commented upon the absurdity of placing a man in the Canadian field and restricting his operations by the allowance of limited means. Too often British firms fail to realize the large expenditure needed for an agency in Canada; too often the sum they allow their agent for travelling expenses is wholly inadequate.

The final point brought out by Mr. Wickes in regard to agents touches upon the inadequacy of the efforts made on behalf of British firms. Mr. Wickes is authority for the statement of instances where agents have absolutely neglected the business of old country firms with the result that it has been found necessary to change the agencies and send representatives direct from England. This is a point around which there might well be profitable discussion.

Herein, perhaps, lies the secret of many difficulties attendant upon British-Canadian trade — **agencies.** When placed in Canada, they are frequently misplaced; when a representative is sent from headquarters, too often he has not the qualifications or executive ability to make the most of his opportunities. As we pointed out previously, Canadians are apt to estimate the character of the home industry by that of the man with whom they have to deal in their own country.

Canada is a land of great opportunities, but the prizes offered to those who strive and prevail in her constructional development are not to be easily won. They are worth the winning and they will be offered for the best service, irrespective of whether that service come from Canada, the United States or Great Britain. In this competitive age, cost, efficiency and time are factors of paramount importance. The purely sentimental regard that the British have for the British is a matter of small count when it comes to dollars and cents—and service.

We take pleasure in complimenting those who are striving to improve trade relations between the mother country and the Dominion, feeling confident that considerable success must attend their efforts—provided the theories propounded give way to practice.

Concerning One-Sided Contracts and their Fulfilment

HAPPILY, or unhappily, legal decisions in the United States are not based upon the code by which we are governed in Canada. In many respects British law is widely at variance with the ordinances by which our neighbors to the south live and have their being. But there are cases in which legal decisions and legal observations find a common level. A case in point is a statement of the Missouri court, which runs as follows: "A man in possession of his faculties and able to read should be bound by what he has signed, even though he did not know what it contained when he affixed his signature."

This subject has recently been the topic of discussion in the American Society of Engineering Contractors and many good points have been made. We cannot but join with the Society in deploring the fact that notwithstanding the great development of the contracting business during recent years there are many contractors, otherwise able and experienced men, who display an astounding lack of knowledge of the law as it relates to contracts. They cheerfully sign contracts by which they barter away their rights to arbitration, and go even to the extent of depriving themselves of the right to appeal to the courts. Contractors secure their final estimates and go, new machinery is invented and construction methods change, but there still survives the old form of contract devised many years ago when the contractor was employed practically by the day. In those times the ordinary contractor was to all purposes a mechanic. He had little capital, small plant investment and few overhead expenses. In many cases he charged so much a day for his men and the difference between his charges and the wages paid was his only profit. His risks were small, he had little to lose, and consequently the contract was not reasonable, because the loss, if any, would fall almost entirely on the party for whom the work was being done. It is different nowadays. Contracting has developed into one of the larger businesses of the country. Millions of dollars are invested in it and thousands of people get their living from it. And yet there are many contractors, good practical men, capable of handling work involving great sums of money, who display a woeful ignorance regarding the law of contracts on which the success of their business depends. The pitfalls into which the contractor is liable to tumble through his carelessness in signing one-sided contracts are legion.

In an address before the National Building Trades' Association, Mr. Charles Carroll cites cases to show the absolute necessity of carefully inspecting every contract to see that the rights of both parties are protected, and emphasizes the fact that no contractor should enter any contract by which he barters away his right to arbitration or which deprives him of his rights to resort to the courts of the land to receive justice. He concludes:

> It ought not to be difficult in this day of thorough organization and thorough knowledge of the details of construction to prepare a contract covering in detail all points of the work and to define them so plainly and so explicitly that there cannot be any controversy as to the meaning of the contract document. The contractor owes it to himself, to the company that becomes his surety for the proper construction of the work, and to his family, that all of these points be so covered in the contract that no controversies can arise concerning them, and it should be provided in the contract that in case of dispute between the contractor and the architect or owner concerning the proper construction of the work where there is a material question involved this question should be submitted to arbitration, composed of disinterested persons selected by each side. In this way each party can have the satisfaction of knowing that this case will be passed upon by an impartial tribunal. One of the parties cannot then have the satisfaction of knowing that the question in dispute will be determined by a judge who has been committed from the beginning and who is personally interested on one side of the question.

Frequently we hear that some contractor has tried to evade the terms of his contract upon discovering that he was accumulating a loss on the work. His excuse is liable to be that he did not read the contract before he signed it. Once a contract is signed it is binding on both parties thereto irrespective of their lack of knowledge, respecting its terms.

One-sided contracts would cease to exist if contractors did two things. In the first place they should read their contracts before signing them and, even better, let a competent attorney advise them. Secondly, together with engineers and others interested in contract work they should organize a powerful organization and draft agreements equitable and fair to both parties. Then they might insist on standard contracts.

The Requirements of the Municipal Engineer*

By H. N. Ruttan†

ENGINEERS do not occupy that place in the public eye to which their education, practical knowledge and ability entitle them. One reason for this is that they are retiring and modest and so abhor the loose theories and statements of laymen on engineering questions that they have a desire only to be left alone and be allowed to go ahead with their work in peace. In the interest of the public, as well as of the engineers, the time has come when the latter should assert themselves and take that place in the discussions of public matters of engineering for which their superior knowledge fits them.

Their influence may best be used in public speaking, in articles written for the press, and, probably more than in any other way by candid expressions of opinion to their personal friends.

The engineering profession, and every profession for that matter, is in a state of development, and it is most important that engineers should be posted as to the exact state of progress made and being made in, at least, the particular branch of the profession adopted by them, in order that they will be able to deal quickly and certainly with proposals brought before them, so that it will not be necessary to make tedious and exhaustive comparison and tests to determine what should be done. Let me illustrate this by a practical example.

An imaginary town in the west wishes to install a waterworks distribution system consisting of, say, ten miles of mains. The news of this is published in the technical papers, the town is at once flooded with manufacturers' agents representing many types of pipe, among which are cast iron, wrought iron, sheet steel, and wood stave of various designs. Now, each of the agents maintains that his pipe is much the best, and that while he does not wish to "knock" his competitors, it is plain to anyone that Smith's pipe should be ruled out for one reason, and Brown's for another, and Smith and Brown say the same about their competitors. What, under these circumstances, is a poor municipal council to do? The Councillors all wish to be good fellows to the agents, who have treated them so well, and taken the discussions with such good humor. They are charitable enough to conclude that all the pipes are good. They do not wish to show favoritism. They are fair men. Therefore they decide they will take two miles of pipe from each of the five agents.

The engineer of the council has not, perhaps, had many years' experience. He has always seen cast iron pipe used, and he mildly suggests to the council that it would be safe to use that pipe. He is not in a position to talk down the salesmen and show up the defects of their respective pipes, because he has not fully posted himself from the experience of other places, and unfortunately the pipe which he thinks least of is represented by that brilliant story-teller, mine of useful information, and all-round good fellow, Jerry Squarehim.

"Pouf!" says Councillor Goodenough, "if the engineer had objected to some of the other pipes, there might have been something in his objection; but to object to Jerry's pipe—Pouf! ! ! Besides, our best plan is to try all the pipes and then we will know which to buy next time."

I won't take up your time explaining the engineer's trouble in laying the pipes. How some of the tenders did not include cast iron specials for the intersections, which involved additional expenditure; how the joints leaked; how the protecting covering of others was abraded in making connections, and how the pipe was eaten out in a few years by acids in the soil. All these things are written in the account book of the now flourishing little city, but they are much too dry reading for the only people interested—the taxpayers.

I have told you this imaginary (?) story in order to impress upon you the absolute necessity of keeping abreast of the times, of knowing and taking advantage of the experience of others, of being in a position to say to your employers: "I do not need to experiment in such a case. I know from the experience of Messrs. Smith and the city of Blankville, that the pipe has not been satisfactory for such and such reasons." Even explicit statements will not always prevent your employers from having their own way, but you will at least have done your duty, and the responsibility will be upon those who disregarded the advice of their own paid official. Unfortunately, the public never attach any responsibility to the members of the council in such a case. They invariably want to know who the engineer was.

Haste in Building

THE modern tendency toward haste in building construction appears to have reached its consummation in the recently reported feat of erecting a two-and-one-half-storey residence, from the cellar excavation to the final plaster coat, within twenty-four hours. From three to four hundred men were employed on the premises simultaneously and every time-saving device known to the builder's trade was utilized. In accomplishing this unusual enterprise the contractors must have had very much the same sensations that an architect feels in attempting to perfect designs for a prospective building within the time allowed by an eager client.

When an experienced business man urges that building operations be started, by contract, on a large apartment house within three weeks from the making of the first sketches, there is good opportunity for the architect to do some much-needed educational work. To tell his client the truth at the outset rather than entirely evade the issue will forestall much ultimate disappointment on the part of the owner and relieve the architect of the odium that attaches to supposed tardiness. To take an inexperienced client "behind the scenes" and give him some idea of the amount of time needed for perfecting the details of his commission is missionary work worthy of a busy architect's consideration, for it may dispel the popular idea that the work is principally pictorial and may be readily done by a clever draftsman in a few hours.

Very few things worthy of perpetuity in art or architecture have been accomplished when speed was the controlling factor. Doubtless the ceiling of the Sistine Chapel could have been decorated within six months, but Michael Angelo would not have cared to sign it as his own. The artist's or architect's function is creative, and such creativeness generally cannot be hurried if the best results are to be gained. The use of mechanical contrivances for lessening the labor of building operations, and the rendering of skill in the drafting room more efficient by wise organization, are legitimate and generally desirable, but to allow too short a time for creating the design or directing the work is to render uncertain results which might otherwise be thoroughly satisfactory. When the exigencies of the case demand, as in the recent erection of a notable bank building in New York, architects have frequently shown a spirit of accommodation in accelerating the work that was equalled only by the excellence of its performance. It is unreasonable, however, for a client to ask an architect to do every day that which is justified only in emergencies.

---

* Extract from an address to Winnipeg Engineering Students.

† Retiring City Engineer of Winnipeg.

Footings, Eccentric and Concentric, and Resulting Soil Pressure

Specially contributed by W. Muir Edwards, M. Sc., Professor of Civil Engineering in the University of Alberta

SAND versus rock as the sub-base for a structure has been a familiar parable to many generations. Contemplating the complete destruction of the house built on the former "when the floods came and the wind blew and beat upon it" whilst its rock-bedded neighbor successfully withstood the onslaught, we may have formed an extremely poor opinion of the suitability of sand as a material upon which to build. Were our structures called upon to resist flood as well as wind this is undeniably true, but should the requirement be only that of supporting a direct load, as is the case in the majority of foundations, then we must readjust our scale of values and place sand quite high when rating the bearing power of soils.

Upon just what basis then are we to judge the bearing power of a soil, and how may we arrive at its capability in this regard? The theoretical solution of the problem involves the theory of conjugate stresses and assumes that the soil is a homogeneous granular mass without cohesion amongst its particles, and that for each material there is a certain angle of repose ϕ (i.e., the maximum angle of inclination at which the free surface of the material will stand). These conditions, of course, do not occur in practice, but such an investigation gives us a means of comparing different soils, and the results obtained by theoretical reasoning are on the safe side, so far as the ultimate pressures are concerned. It neglects, however, the very important fact that compression of the earth may take place under the load and hence undue settlement occur in developing the full resistance of the material.

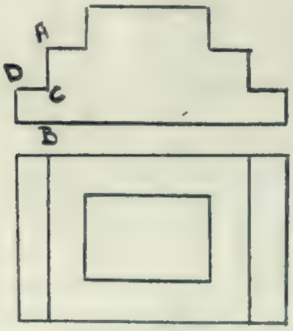


Fig. 1

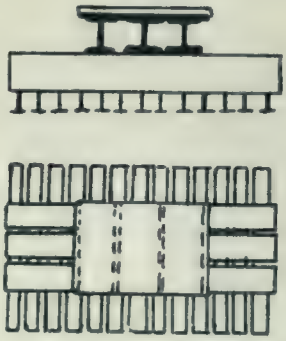


Fig. 2

The formula giving the theoretical resistance of the material to the applied load is

$$p = wh \left\{ \frac{1 + \sin \phi}{1 - \sin \phi} \right\}^2$$

in which w is the weight of a cubic foot of the material, h is the depth of the plane of pressure beneath the surface of the material, ϕ is the angle of repose and p is the allowable pressure. If w and h be in pounds and feet then p is in pounds per square foot.

As an example of the application of this formula we might take the pressure allowable at a depth of 3 ft. in a soil whose angle of repose is 30 deg. and whose weight per cubic foot is 90 lbs., then $p = 90 \times 3 \left\{ \frac{1 + .5}{1 - .5} \right\}^2 = 2430$ lbs., or about 1¼ tons per sq. ft.

It will be seen that the depth to which the foundation is carried is, according to the formula, an important consideration since the pressure varies directly therewith. In general practice, however, it will be found that it is usual to specify a certain bearing capacity for a given soil, no mention being made of the depth. The load allowed by the building by-laws will vary according to locality, the regulations usually stating a maximum load for given kinds of soil or requiring a certified test of the actual bearing power, which test must be reported to the building inspector. The allowable loading per square foot for different soils is, as has been said, of a somewhat arbitrary nature, but is usually considered as being about as follows (The values are taken from Merriman's Civil Engineer's Pocket Book):

Clay—in thick beds always dry, 6 to 8 tons; in thick beds moderately dry 4 to 6 tons; soft, 1 to 2 tons. Sand—dry, compact and well cemented, 4 to 6 tons; clear, dry, 2 to 4 tons. Alluvial soils, etc., ½ to 1 ton.

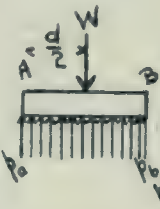


Fig. 3

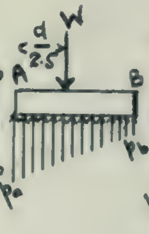


Fig. 4

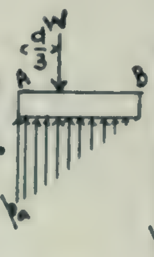


Fig. 5

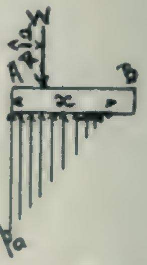


Fig. 6

In regard to the value of ϕ used in the theoretical investigation 27 deg. would be a minimum value for a firm soil and 45 deg. might be taken as a maximum value for material fulfilling the conditions upon which the assumptions are based.

Footings

The allowable pressure on the material of which the foundations are composed is, of course, much higher than the above. For 1:3:6 concrete, for instance, the crushing load might run 125 to 150 tons, and for medium brickwork a safe load is from 5 to 10 tons. It is thus necessary to distribute the load carried by columns or walls over larger areas than their own cross-section before it is transmitted to the soil. This is done by widening the area of the footings by successive steps, until the required bearing surface is obtained, or by using a grillage of beams by which the concentrated load is gradually distributed.

In Fig. 1 is shown the plan and elevation of a stepped footing and in Fig. 2 a plan and elevation of a grillage. In the stepped footing the widths and depths of the steps must be calculated considering the footing as a beam subjected to a uniformly distributed load on its under side.

In Fig. 1, for instance, using a safe bearing of 2 tons per sq. ft., the BM at the section AB, considering a 1-foot strip of the wall, is $4000 \times X \times X/2 = 2000X^2$ foot-pounds. This must be opposed by the moment of resistance of the section CB. The depth of the course CB will thus govern the width of the step CD.

In a grillage of steel I-beams the calculation of the developed stresses is somewhat more definite. The beams forming the under grillage are calculated as double cantilevers carrying a uniformly distributed load on their under side.

Eccentric Footings

Given the safe bearing power of the soil it is a comparatively elementary matter to calculate the safe central load that may be applied to any given foundation. Should the load be not central, however, the intensity of pressure on the soil is not given by dividing the total weight by the bearing area.

It is somewhat difficult to say with exact precision just what are the reactions which take place between the foundation and the soil upon which it rests, but it is quite evident that since there is stability the resultant of the soil pressures must be axial with and equal in magnitude to, the resultant of the foundation loads.

Considering Figs. 3, 4, 5 and 6, let R be the resultant of all the resistances offered by the soil. Then R and W must be equal, opposite and in the same straight line.

It is obvious that there must be a gradual change in the intensity of pressure and it is assumed that the change is uniform (i.e., ab is a straight line). Let p_a and p_b be the intensity of pressure at A and B respectively due to a load W applied as shown. In each case, since ab is a straight line

$$R = \frac{p_a + p_b}{2} \times AB = \frac{p_a + p_b}{2} \times d.$$

Also p_a and p_b must bear such a relationship that R, the resultant of all pressures, must always be in line with $\overline{W}$ the resultant of the applied loads.

If $\overline{W}$ be the load per lineal foot of the foundations and d be the width of the foundations in feet,

In Fig. 3 $p_a = p_b = \overline{W}/d$.

In Fig. 4 there are two equations to solve for p_a and p_b; these are (1) since $\overline{W} = R$ then $\frac{p_a + p_b}{2} \times d = \overline{W}$.

and (2) since $\overline{W}$ and R are concentric

$$\frac{p_a}{2} \times \frac{d}{3} + \frac{p_b}{2} \times \frac{2d}{3} = \frac{p_a + p_b}{2} \times \frac{d}{2.5}$$

Solving these $p_a = \frac{8}{5}\left\{\frac{\overline{W}}{d}\right\}$ and $p_b = \frac{2}{5}\left\{\frac{\overline{W}}{d}\right\}$.

In Fig. 5 if we solve we will find that $p_a = 2 \frac{\overline{W}}{d}$,

and that $p_b = 0$.

If we apply the same reasoning to Fig. 6 p_b would be a minus quantity. It is obvious that the earth cannot exert tension on the foundation and therefore there is a non-continuity at this point and cases represented by Fig. 7 are solved by the assumption that as before R = W and is concentric with it, and that the intensity of pressure varies from a maximum to 0, as a minimum. "x," the width of the foundation exerting pressure, under these assumptions, must in this case satisfy the equation $x/3 = d/4$, or $x = \frac{3}{4}d$, and the maximum intensity of pressure p_a is given by the equation

$$\frac{p_a}{2} \times \frac{3}{4} d = \overline{W}.$$

$$\text{or } p_a = \frac{4}{3} \quad \frac{2\overline{W}}{d} = \frac{8}{3} \quad \frac{\overline{W}}{d}.$$

If, then, $\overline{W}/d$ is the allowable intensity of pressure for a given soil, the eccentricity of the loading would not only make an unequal loading on the soil (in itself an extremely detrimental result) but would give a maximum intensity of soil pressure 2 2/3 greater than the allowable amount.

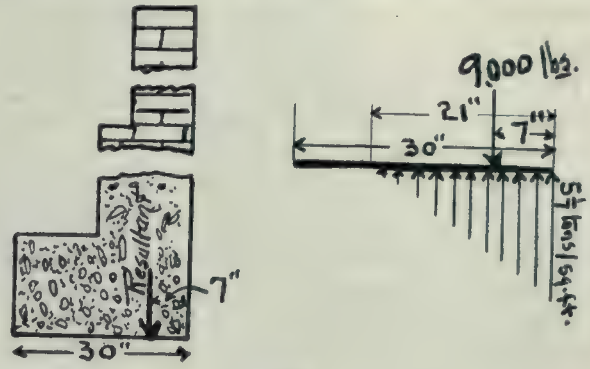


Fig. 7

It would seem that such results would not obtain in practice. On the contrary, however, they are responsible for many of the unsightly settlement cracks seen in buildings and in many cases the neglect of this factor of eccentricity has led to the total destruction of the structure.

One very common occurrence of eccentric loading is the widening of the foundation under a party wall to obtain the required area, entirely on one side of the property line.

For instance, a five-storey concrete and brick wall, 16-in. for the first two and 13-in. for the balance, might weigh 9,000 pounds per lineal foot of wall and the centre of the applied loads lie 7-in. from the outside face of the wall.

As shown in Fig. 7, the width of wall required for a soil bearing a load of 2 tons per sq. ft. under a centrally-placed load of 9,000 pounds is 2½ feet or 30-in. But should such a width of footing be put in the actual distribution of stress in this case will extend over only 3 x 7 = 21 inches instead of the total width of a 30-in. and the maximum intensity of pressure will be given by

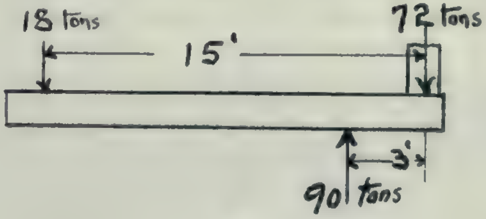


Fig. 8

$p/2 \times 21/12 = 9000$, or $p = 24/21$ of $9000 = 5\ 1/7$ tons per sq. ft.

In the above not only is there an excessive intensity of pressure but since there is such a great variation in the intensity the outside of the footing would have a much greater tendency to be driven into the soil and thus there would occur an outward turning moment on the wall.

Constantly there are cases where it is necessary to erect structures such as party walls and several methods may be adopted to provide suitable foundations. All of these should look to (1) a uniform distribution of the load to the supporting soil and (2) that the safe bearing power of the latter is not exceeded. Two of these methods might be mentioned—(1) a cantilever footing, (2) pile foundations.

Cantilever Footings

As the name implies, a cantilever footing carries the load on the end of a lever, the upward thrust at the other end being suitably provided for and the reaction of the fulcrum being carried to the soil in such a manner that the safe bearing power will not be exceeded. The case discussed in Fig. 7 might be outlined as follows, assuming that the wall is carried longitudinally in bays of, say, 16 feet, and concentrated on the end of a cantilever.

Referring to the diagram in Fig. 8 it will be seen that if the cantilever be 15 feet in length and the fulcrum be 3 feet from the 72-ton load, then the load on the other end required to just balance the 72 tons would be 18 tons and thus the load on the fulcrum would be 90 tons. If the allowable bearing on the soil beneath the footing is 2 tons per sq. ft. we would require 45 sq. ft. as the area for the base of the supporting pier. In addition to the wall load here provided for there would be other loads, such as the floor load, the live load and the wind load, to take into account. These would increase the load on both ends of the cantilever and thus the required bearing area might be larger than 45 feet. By suitable design, however, the fulcrum load may be applied centrally and the required area for the footing obtained within the property line.

Piling a soil increases its bearing power in two, and possibly three, ways: (1) it tends to compact the soil; (2) it transfers the load to a much lower plane, so far as the soil is concerned, and hence applies the load at a point where the allowable pressure is much higher than near the surface; (3) there is a very great increase in the resistance of the pile as compared with the earth which formerly occupied the same space, due to the friction between the surface of the pile and the earth into which it is driven. This latter quantity is a considerable amount and accounts for the much higher pressure that piled ground will carry. The piling thus increases the value of the allowable intensity of pressure. In the case already cited in Fig. 7, if we wish a central load the available width for the footing is 14-in. and hence the resistance of the soil must be brought up to 9000 x 12/14 = 7714 pounds per sq. ft., i.e., a bit under 4 tons per sq. ft. As in the case of the cantilever footing this would be increased by the loads not here considered.

As has been said, the whole stability of any structure is dependent in the first place on the efficiency of its foundations. If reliable data is not available, tests of the bearing power of the soil should be carried out. Careful design requires not only a maximum intensity not in excess of the safe bearing power, so determined, but should also insist on uniform intensity of pressure throughout the foundations. The latter is as important as the former, uneven settlement being the cause of the majority of foundation failures. Too often great care is expended in beautifying, in fireproofing, or on some other feature in design, and the foundations are slapped in by rule-of-thumb or by no rule at all; but they require and should receive as much careful design as is given to the part above ground. Although out of sight the foundations are certainly one of the most important features of the structure.

Dunn Wire-Cut-Lug Brick

In our report of the Montreal Road Congress, published in our issue of May 27, there were a number of erroneous statements concerning the Dunn Wire-Cut-Lug Brick Company which call for correction. We referred to this company as "among the most important manufacturers of paving brick in the United States," and as having "the largest continuous kiln in the world," whereas the company does not manufacture brick, but is a licensor of manufacturers. The kiln is owned by the Bessemer Limestone Company, of Youngstown, Ohio, who had a joint exhibit with the Dunn Company at Montreal. The announcement that the Dunn Wire-Cut-Lug Brick Company license the manufacture of wire-cut- lug brick has been made repeatedly in the advertising columns of this journal and we are pleased to emphasize the fact editorially.

An Important Terminal Scheme

The province of Ontario is undertaking an important development in establishing a terminal port at Moose Harbor. One of the features of the scheme is a 185-mile extension to the Temiskaming & Northern Ontario Railway at a cost of some five million dollars.

The most advantageous location for the proposed terminal so far as present information goes is at the mouth of the Moose River. The distance from this point to Toronto is approximately 670 miles. The first definite information concerning the locality was obtained by engineering parties sent out in 1911, which made a complete instrumental survey of the estuary during that season. It was found that Moose Harbor provides an excellent site for the creation of a great port. The estuary is perhaps 20 miles long and varies from 1½ to 3 miles in width. It is crowded with islands, and through the intervening channels there discharges a river, which so far as known, was never smaller than the Ottawa River. The settlements and fields on the islands have been long occupied and the flat-lying shores provide an ideal site for a rail and water terminal.

The surveys of 1911 showed that the river was divided into two great channels and that the depth of water in these channels varied to such an extent that their improvement would be expensive. Further on, however, these channels form into one broad and deep waterway, bordered by very extensive sand bars. The depth of water in the main channel varies at low tide from 15 ft. to 20 ft. but the fairway is cut off from the main bar by a bar having a total width of about 4 miles and a minimum depth of water of 6 ft. Beyond the bar the depth of water steadily increases until at a short distance out soundings are secured that are satisfactory for any probable navigation.

It is not believed that traffic conditions will justify the construction of a channel of more than 15 ft. depth at low water. The excavation of a 300-ft. channel of this depth out to the bay should cost in the neighborhood of $600,000. It is believed that in the earlier years of its development no better plans can be made for Moose Harbor than those that have worked successfully for so long in Montreal. There is an excellent site on the north shore of the estuary, extending from the port of Rivillon Freres to the head of Sandy Islands for a development on the Montreal principle. The channel in front of this shore is of satisfactory depth and the lands behind it have the proper contour for an efficient railway yard. The cost of the 1,000 ft. of crib wharfing at this place may be estimated at approximately $150,000.

The work that has been done up to date has proved beyond question that the construction of a deep water terminal at Moose Harbor is perfectly feasible, and that it does not involve more than a very moderate expenditure. It may further be stated that the exploratory surveys for the railroad extension from the present terminus at Cochrane to the harbor are so well advanced that this portion of the undertaking is known to be a piece of railway construction of the most ordinary type. It is therefore probably only a question of a short time before the Provincial authorities will take up the extension of this railway and the construction of terminal facilities on James Bay.

Modern Refuse Disposal Practice at Halifax, N.S.

THE council of the city of Halifax, realizing the danger and annoyance caused by the old system of dumping the waste collected in the city, instructed their engineer, Mr. F. W. W. Doane, to prepare specifications for a modern disposal plant to dispose of this waste in an economical and sanitary way. These specifications were drawn, calling for a high temperature destructor capable of burning to an innocuous inorganic ash fifty tons in twenty-four hours of the ashes, garbage, combustible rubbish, manure, carcases and night soil as collected.

The Griscom-Russell Company, of New York, American representatives of Messrs. Hughes & Sterling, of London and Liverpool, prepared plans and specifications for a Sterling refuse destructor and Messrs. Dongard Bros., of Halifax, N.S., were awarded the contract for the construction of the plant in accordance with the plans submitted. The contract price for the entire plant was $41,775.

The plant consists of a two-storey reinforced concrete building, absolutely fireproof throughout. Access for the collection wagons to the second storey or receiving room is by means of a long inclined wooden runway. The collection wagons empty their contents in the receiving room into a large steel storage hopper, which is designed to hold the collection for an entire day. The receiving room has two wagon doors, so that when a wagon is emptied it can pass through the side door to an extension of the runway without blocking the entrance of other wagons into the receiving room.

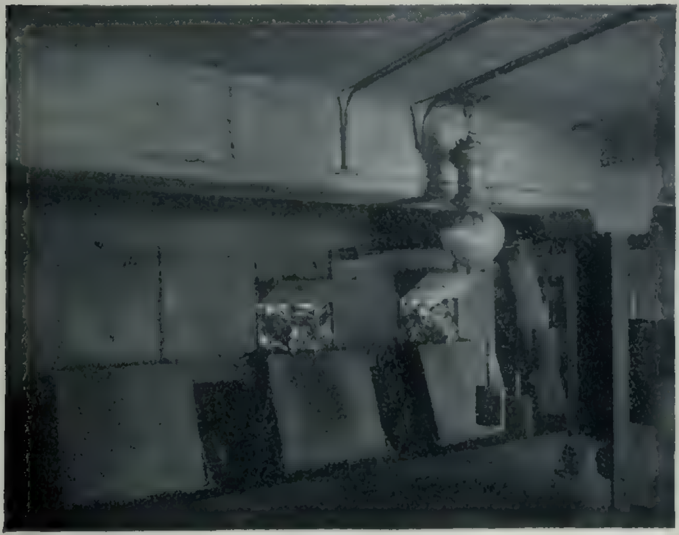
Through doors in the bottom of the receiving hopper the material to be burned falls into steel containers, of which there is one over each furnace cell. The operator working on the charging platform keeps these containers filled and when the foremen desire, one is released and discharges its contents into the furnace below. The releasing mechanism may be operated from the charging platform or from the furnace room floor. The combination of this swinging container and quick opening furnace cover forms a simple and satisfactory method of mechanical charging.

The destructor furnace consists of three standard Sterling cells and a common combustion chamber. Each cell has an ample drying hearth. All surfaces exposed to the high heat are protected by a 9-in. wall of fire brick blocks. This fire brick is of a special grade, thoroughly tested to withstand the severe service. The furnaces are heavily stayed and reinforced by steel and iron plates, beams and tie rods. The grates are of the special Sterling pattern surrounded by massive air-cooled castings which prevent injury to the brick work when stoking or clinkering.

Halifax disposal plant, showing chimney and runway.

From the combustion chamber the gases pass through a 200 h.p. Root water tube boiler and then through a steel tube regenerator, where the air for the forced draught is heated. From the regenerator the gases pass to a 115 ft. radial brick chimney lined to the top with fire brick.

A bypass connects the back of the combustion chamber with the regenerator and chimney, so that by



Charging floor. Front of container.

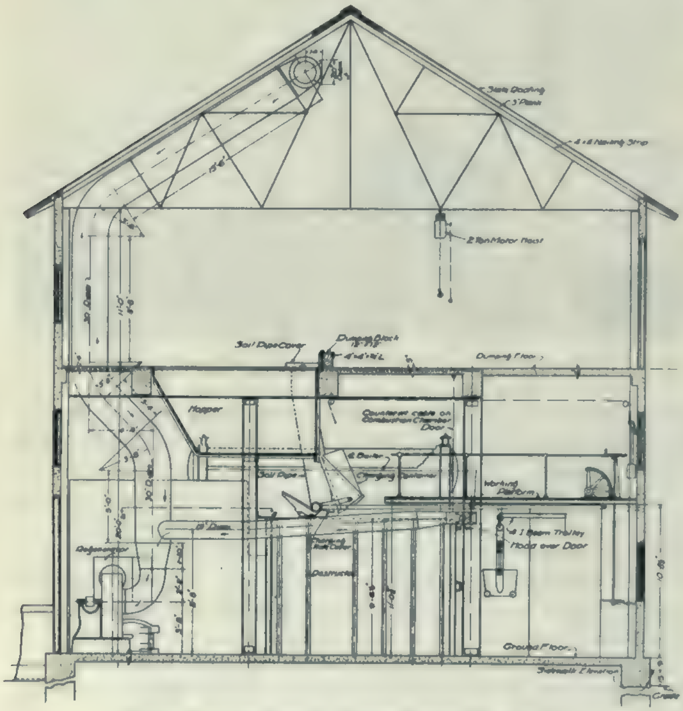
Rear of cells. Engine and fan for forced draft.

adjusting dampers it is possible to cut out the boiler and send all or a portion of the gases through the regenerator, the remainder passing to the chimney.

The bottom of the combustion chamber is a deep sloping hearth on to which the night soil is delivered from a steel chute running to a manhole in the receiving room floor. The intense heat in the combustion chamber soon evaporates the moisture and burns the organic matter in the night soil without the slightest odour, leaving an inoffensive mineral residue.

The building is thoroughly ventilated and kept free from smoke and dust by a combined ventilation and forced draught system. An engine-driven fan draws the air through steel ducts from the charging floor and from the front of the furnace, delivering the foul air to the regenerator, where it is heated by the waste gases and conducted to the ash pits under the grates. The amount of draught is regulated by a butterfly valve in the hot air pipe line to each cell.

The plant is lighted by electric generator and a direct connected steam engine using stem from the boiler. A number of arc lights are placed on the runway and in the yard and building these being supplemented by numerous incandescent lamps.



Halifax disposal plant. Section through building.

The clinker, as it is drawn from the furnace cells, falls into a large steel bucket, which runs on a monorail crane. This crane rail extends into the yard where the clinker is dumped and allowed to cool. A rotary crusher, with screen and elevator, is installed to crush the clinker for use in sidewalk slabs, concrete work and road making.

A Brown electric pyrometer is installed to record the temperature in the combustion chamber. A Simmance-Abody combustion recorder is installed to analyze and record the amount of carbon dioxide in the gases of combustion. A Bristol recording gauge makes a record of the stem pressure.

On official test, March 8, 1913, the destructor burned at the rate of seventy tons in twenty-four hours, exceeding the guarantee by forty per cent. The material burned consisted by weight of 75 per cent. unscreened ashes, 16 per cent. wet food refuse, or garbage, and 9 per cent. combustible rubbish and refuse. The ashes to be burned were mostly from house furnaces and closed stores and were very low in calorific value. This was shown by screening a sample, when 45 per cent. passed through a fine screen.

The average rate of burning during the test for the three cells was 77.7 pounds the square foot of grate surface an hour. One cell burned at the rate of 89 lbs. the square foot of grate surface an hour.

The evaporation in the boiler was 1.53 lbs. of water F & A 212 deg. F. for each pound of material burned. Thus 258 boiler horse power an hour was being generated. The average boiler pressure was 145 lbs.

The average CO_2 was 9.94 per cent. The average temperature in the combustion chamber was 1357 deg. F. The average interval between clinkering was 92 minutes. The average time to clinker was 8 min. The operating crews consisted of three men and one extra helper during the day shift. The specified wages were 30c and 17c an hour. This gave a labor cost of 28c a ton.

At another period the residue from the furnaces was carefully weighed and 22.8 per cent. of the material burned was converted into very hard vitrified clinker suitable for crushing.

This work is now being carried on in Canada by the Canadian Griscom-Russell Company, Limited, 736 St. Paul Street, Montreal.

In laying out construction work, lines are usually strung between batter boards. Some contractors use wire for the main lines and find it satisfactory. A light wire, about 18-ga., can be used satisfactorily. The only trouble is that the wire rusts and is practically wasted, and some contractors might not consider its use an economy. On the other hand, on lines of great length, the wire stretches less and can be pulled so much more taut. An ordinary cord has to be taken in at night to both save it and to prevent it from shrinking and snapping in case of a rain. Wire, however, can be put up once and left up until its use for that particular line is past.

By keeping currents of several hundred amperes flowing continuously through water pipes which otherwise would have been in danger of freezing, it was possible to continue construction work on the hydro-electric development of the Cedar Rapids Manufacturing Company, near Quebec, without interruption during even the coldest days of the past winter. The 1-in. pipes thus protected supplied water for the steam shovels and were laid above ground, as continuous shifting prevented them from being buried. Current for the pipe circuits was obtained from a bank of transformers stepping down from 2,300 to 220 and 110 volts. The pipe connections consisted of copper wires wound around the ends of the pipes and buried several feet in the earth to prevent the pipes from freezing below the connections. When the temperature was below zero, and even as low as —27 deg. Fah., it was found that 40 kilowatts at 220 volts would keep 1,500 ft. of 1-in. pipe from freezing, even with water standing in it. A 1,000 ft. pipe required 20 kilowatts at 110 volts.

A concrete buoy has been constructed at Kingston, Jamaica, at about one-half the cost of a steel buoy. The bottom is made concave so as to protect the eyebolt from the mooring chain. Reinforcing bars are used, and the total weight is about five tons.

Concrete Roads versus Foundations

Use of Concrete as a Surface Material Under Horse and Automobile Traffic — Advantages and Disadvantages — Difficulty of Repairing

By Major W. W. Crosby

FOR the sake of making clear the statements to follow, let it be assumed primarily that a concrete road is one in which the artificial surfacing for the roadway is built of a concrete composed of hydraulic cement, sand and gravel or broken stone, all of predetermined proportions, and is not covered, or protected from wear, by a carpet or coating of appreciable thickness of pitch and other material. Then all those roadways in which a cement concrete layer is covered by a carpet of pitchy material will naturally fall together into another class where a "concrete base" or "foundation" supports a wearing surface composed of block paving, sheet or rock asphalt, bituminous carpet, etc., and in the consideration of these instances of the use of concrete, the concrete will be referred to as the "concrete foundation." Further, it should probably be understood that in writing the following the author had in mind, when he referred to a road or streets, those public highways on which a considerable amount of animal drawn and of hard tired traffic might be expected along with motor traffic carried on rubber tires. In any case where the road crust is not open to use by an appreciable amount of the former traffic, some of the remarks made might have to be considerably modified.

The use of concrete for both road surfaces and road foundations is not new. Thirty or more years ago the concrete road (in the above described sense of the term) was "discovered," tried out and abandoned. It was found to possess certain inherent defects under the then existing conditions, and these proved so serious that its economical use was found to be limited so as to result in the practical abandonment of this form of surfacing for the time being. With the changed conditions now existing, the use of concrete for roadways has again begun. The increase of traffic has demanded stronger roads. The reduced ratio of horse-drawn to total traffic has changed the average character of the stresses on the surfacing material. The immense reduction in the cost of hydraulic cement and the improvements in machinery for mixing and placing the concrete have aided the latter to compete with other road crusts in first cost and also in long-run costs. And it seems to the writer that under the changed conditions there are at present many cases where existing circumstances—such, for instance, as poor natural foundation for and heavy traffic on the road, or convenience in the supply of materials for concrete—justify or even demand its selection for at least a part of the road crust. On the other hand, the tendency of certain road authorities and others to rush to concrete as a panacea for all road ills is to be deplored as both irrational and extravagant. In these days the great problem for road authorities is the proper selection of the form of construction best suited for the circumstances of any particular case, and a sufficient variety of surfacings, including concrete, is now available to permit true economy to be had by a proper choice.

Of the factors influencing the decision for or against the selection of concrete as the road surfacing may be considered: Cost (first and long-run), Durability, Ease of Maintenance, Cleanliness, Resistance to Traction, Slipperiness, Sanitariness, Acceptability, Favorableness to travel.

Cost—Only too frequently this consideration is limited to first cost and fails to include, as it should, the interest charges on first cost and the cost of maintaining the pavement in as good condition as when first completed (or a depreciation charge) in order that a fair comparison may be drawn. Concrete can never be as low in first-cost as macadam under the same conditions because of the introduction into the former of cement for which an additional cost has to be met. Ordinarily, though, competition may be had—often successfully—by a proper assumption that a less thickness of concrete will be as strong as the macadam to be prescribed; and further, that it is frequently possible to use in the concrete a local material for the aggregate which may be secured at a smaller cost than necessary for a proper stone for the macadam. A local granite may make an excellent concrete when it would prove entirely unsatisfactory, because of its lack of binding qualities, for macadam, and if macadam were to be built, the cost of importing a suitable stone might offset the additional cost of making concrete from the local granite.

In the same way, where small, sandy gravel is plentiful in a locality and good stone for broken stone macadam is required to be imported at a considerable expense, frequently gravel concrete roads or gravel concrete foundations carrying a bituminous surface will be found to be the economical solution.

Contrary to the arguments of many of the advocates of concrete roads, a concrete surfacing is not permanent in the sense that it will last indefinitely without repair. It is unfortunate that in the advocacy of modern road improvement the use of this word "permanent" has been so indiscriminate. No road surface is permanent. All require repairs from time to time if they are to be kept continuously in good condition, and the use of the word "permanent" in the arguments for better roads has been deceptive. Its abuse has produced disappointment, frequently a reaction against the movement, and often extravagance in later expenditures. It is questionable whether or not the cement manufacturers themselves, to whom many of the arguments for concrete roads may be traced, are working for their best interests in the end by their reference to concrete as "a permanent road" surfacing.

MAINTENANCE AND REPAIRS

Concrete roads, in addition to the interest charges to be figured in their long-run cost, require continuous expense for maintenance and repair. Except possibly in those cases where a curb adjoins the edges of the concrete roadway, the shoulders (even if the concrete itself does not) begin to need maintenance the day after the completion of the roadway. The usual sudden transition from the rigid concrete to the softer shoulder material produces, under the first heavy vehicle that in passing turns out and off the concrete, a depression or rut along the edge of the concrete. This depression or rut is a vulnerable spot in the armored road and must be immediately protected, by repair, against serious consequences from the entrance of water or from material damage to the edge of the concrete itself. These points of weakness, which also are likely to occur between the earth shoulders and any road surfacing, are, in the case of concrete roads, more frequent and of greater extent, because of the greater difference in rigidity between an earth shoulder and the concrete than between the same kind of shoulder and a gravel road for instance. While the shoulder maintenance may not be a part of the maintenance charges for the concrete itself, it certainly is a part of the road maintenance, especially where, in order to keep the first cost down, the concrete surface has been built too narrow in width to carry on it all the traffic, and a considerable portion of the latter constantly turns out onto the shoulders. Certain road authorities have seemed frequently to neglect, in deciding widths or character of surface to be built, a proper consideration of the comparison between shoulder maintenance costs and interest charges plus surfacing maintenance costs, with the results of dissatisfaction to the road user and excessive costs in the end to the contributors.

The concrete surfacing itself will, after a period dependent of course on local conditions, require repairs, and it is an inherent difficulty of concrete that repairs to it are not easily made. This fact was one of the main reasons for the abandonment of the earlier efforts to use concrete for road surfaces. While these repairs may seem in some respects relatively slight, the expense for them will be inversely large.

Reliable figures of cost for maintenance of concrete roads are not as yet at hand, but the foregoing may serve to indicate, from the point of view of cost, the factors to be considered in this connection and the points of weakness in some of the arguments that have been advanced for the more general adoption of concrete road surfaces.

EASE AND INFREQUENCY OF REPAIR

Reference has been made to the fact that concrete is not easy to repair. The frequency of repair may depend largely on local conditions, but it is also affected by certain peculiarities of any concrete. The mixing together of four different materials and the placing of the resulting mass in the roadway give many opportunities for irregularities to occur. A most desirable feature of any road surface is an ability to wear uniformly, and this is frequently, if not generally, more desirable than a less uniform, even if slower, rate of wear. The difficulties in the way of the necessary high degree of uniformity in cement concrete for road surfaces are apparent when it is recognized that few sources of broken stone deliver a uniform product; that there is frequently considerable variation in the ledge or quarry itself; that there often is variation, even between the products of different days, from the crusher and screens, and that segregation of the smaller from the larger sizes generally occurs in loading, shipping and handling this product. The same may be said as regards the sand in many cases. The quantity of water present in the mixture is frequently more or less irregular and segregation and other causes for non-uniformity generally arise during the mixing and placing of the concrete. All these contribute to the presence so generally noted in concrete road surfaces of spots of unequal abilities to resist wear and to the consequently resulting holes so difficult of proper repair, which form one of the main obections to this type of pavement.

It might be said here that, while proper supervision does reduce to some extent the lack of homogeneity in results, certain inherent irregularities can be reduced only by mechanical means while certain others seem inevitable. For instance the natural irregularity in position of the stone in the surface of the placed concrete may be reduced to a considerable extent by rolling so that, just as in good broken-stone macadam the majority of the larger pieces of stone in the surface will lie with a face exposed to subsequent wear instead of an edge, as is found in most cases of insufficiently rolled macadam. Harrowing a layer of broken stone will result in greater uniformity as to size of the pieces of stone in the surface. Hence there seems to be good ground for some of the claims of the advocates of a concrete road surface formed by grouting the broken stone spread and rolled in place such as in the Hassam pavement. Further, the mechanical bond thus secured between the stone particles is worth considering as an additional factor for strength and durability.

Concrete is not easily repaired so as to be satisfactory. In the first place, the difficulty of remedying a slight depression worn into the surface under traffic generally leads to letting such a defect increase to material dimensions before attempting its repair, which is of course objectionable. To repair any depression with any degree of satisfaction it has been found necessary that the depth of the hole be, or be made, sufficient to provide space for placing in it aggregate of the same size as that which forms the adjoining surfaces and flush with them. Also it is necessary that the new concrete be of uniform thickness, not tapering off at the edges. This means that for the proper repair of a hole the old concrete must be more or less cut away—a rather expensive proceeding. Even then if a good bond —a difficult matter frequently—is not secured between the new and the old concrete, the joints in the surface soon become objectionable. When the ordinary concrete road surface begins to need repair, it is practically only a question of a short time when the concrete surfacing will have to be abandoned as such and turned into a concrete foundation because of the difficulties of repairing the concrete so as to leave it satisifactory as a road surface.

If a concrete road is built of gravel, notwithstanding that the average strength of gravel concrete is greater than with broken stone concrete, the lack of mechanical bond obtainable from the rounded stones in the surface renders the latter particularly susceptible to damage by the shod feet of draught animals. The blow of a horse shoe may break the cementing mortar around a stone and the pushing or twisting of the foot may then easily dislodge the stone from its place. Of course, the adjoining stones are then more easily dislodged and the hole in the surface grows rapidly and needs repair.

The difficulties of proper repair are so well recognized that many engineers are now recommending such work to be done with bituminous concrete instead of cement concrete, but of course this is only a step toward the ultimate transformation of the concrete road (surface) into a concrete foundation.

Again, it seems pretty generally agreed that concrete roads are liable to objectionable cracking under the influence of changes in temperature and in the conditions regarding moisture present. After being placed, the wet concrete shrinks considerably in setting and drying, and this change of volume produces cracks in the surface. These cracks form points of weakness and foci of deterioration more or less serious, according to their distribution and concentration. The effort is usually made to concentrate them in regularly occurring joints, and these joints are predeterminedly built in place with cumbersome iron or steel plates which themselves are objectionable to traffic. These expansion joints increase in obnoxiousness as the road gets older and wears down, and ultimately, in order to relieve this feature, if for no other reason, the coating of the whole road with a bituminous or other surface or pavement is necessary. If these expansion joints are not provided in the first place, the concrete road surface develops cracks irregularly under alternate wetness and dryness or heat and cold, and these cracks break away on their edges and ultimately develop into objectionable places in the surface. Apparently the only remedy then is to cover the entire surface with a carpet or pavement. The concrete road then becomes a concrete foundation, and if it can be foreseen that such an end is probably to result within a limited time the writer believes that reasons of economy demand its careful consideration before reaching a decision to attempt the concrete road construction in the first place.

Ease of Maintenance.—Special machinery is not required for maintaining concrete roads, and in this respect they may have an advantage over such pavements as bituminous concrete and sheet asphalt. Heaters, mixers and unusual tools are not required, nor even steam rollers for at least any but the largest jobs.

Cleanliness.—Concrete pavements are fairly easily kept reasonably clean. They are perhaps less susceptible of dustlessness and thorough cleanliness than is an asphalt surface or the best brick pavement; but, on the other hand, they are more so than macadam or even the ordinary good stone block pavement.

Resistance to Traction.—This is extraordinarily low in the cases of concrete pavements, and few pavements go ahead of them on this point.

Slipperiness.—Concrete pavements are generally more slippery than macadam and stone-block pavements (except in those cases of the latter where the joints are filled with cement mortar) but less so than wood, asphalt, bituminous pavements generally and well laid brick pavements.

Sanitariness.—Concrete pavements are slightly less equal in this respect to the best laid brick, and are sanitary than bituminous surfaces and pavements; are more sanitary than stone block pavements or macadam.

Acceptability—i.e., the bases of personal or local preferences and of aesthetic consideration and of noiselessness. As before referred to, the writer is aware that at present there exists in many minds a prejudice more or less strong toward the selection of concrete for the road surface, regardless of facts. That the propriety of this state of affairs may sometimes be successfully questioned he has attempted to show. As to aesthetic considerations it may be noted that the glaring effect of the mortar in the concrete is frequently objectionable, even when dark-colored stone are used for the aggregate. On the other hand, a light color of the concrete may be beneficial for unlighted roads through woods, especially where there is much travel at night. As to noiselessness, concrete pavements offer slight objections on this account. They are productive of more noise than bituminous surfaces and pavements or macadam but of less than brick or stone blocks.

Favorableness to Travel.—Concrete pavements are somewhat less favorable to travel than macadam or bituminous surfaces and pavements and more favorable than stone blocks or bricks in that their surface rigidity lies between the two types mentioned. An extremely rigid inelastic surface is objectionable to passengers over it even when the vehicular devices for lessening the inevitable shocks are of the highest efficiency. Animals naturally prefer the softer materials on which to tread, especially when unaccustomed to metalled or paved roads. As the proportion of surfaced to unsurfaced roads increases, the latter objection to concrete is somewhat reduced. Complaints have reached the writer from motorists using newly-completed stretches of concrete roads that an unpleasant vibration was noticeable to the passengers in going over such roads, and it seems probable from the description and the writer's own experiences that such vibration was due to minor unevennesses in the surface, unnoticeable to the eye or at low speeds. If the speed be high enough, this vibration can be detected on the best concrete roads, though it seems imperceptible on macadam or on good bituminous surfaces and pavements.

Those who lean toward concrete roads (using the term as perhaps it is more loosely and generally now applied) may attempt to meet the objections offered above by the writer to concrete roads under his definition of the term by suggesting, as is frequently done, that the removal of nearly all grounds for objection and a considerable strengthening of the arguments for the more general use of concrete for roadways may be had by **providing a bituminous surface on the concrete.**

Now this point is the rock on which it appears that so many commanders of the good ship Economy and Efficiency have come to grief. If the concrete layer is finally to be treated as a foundation, why go to the extra expense necessary for even fairly successful use of it as a surfacing? Why make it a 1:2:4 mixture if a 1:3:6 has been so often satisfactory? Why pay for floating and otherwise finishing its surface if this can be just as well avoided by finally surfacing with a bituminous material? Why bother with and pay for unnecessary expansion joints? Foundations seldom have required them.

The reasons for separating the consideration, according to the definition proposed at the beginning by the writer, he hopes may now be apparent. After all, when a concrete layer is to be covered by a bituminous carpet or by a block pavement, are not the considerations regarding the concrete those old ones of sufficient thickness and strength to enable it to perform its purposes, of its composition with gravel or broken stone as may be desirable for economy in first cost, and generally for a road surface? And then, as regards the surfacing layer, are they not the same old ones of character, of thickness, of composition, all to fit best the local conditions?

There certainly is room in the practice of highway engineering for the better and more scientific selection of road crusts. Many are doubtless familiar with instances of good pavements that have satisfactorily survived many years on a cheap gravel or sand foundation with only reasonable charges for maintenance, and as familiar with other cases where economy would evidently have been had from the installation of a concrete foundation in the first place. It really seems to the writer that the far larger part of the consideration concerning concrete roads (using the term in its broadest, and perhaps at present more general, sense) is composed of two main parts; first, as to the advisability of providing a concrete foundation for the surfacing; and, second, the determination of the character, composition and thickness of the latter.

If highway engineers will but regard the facts in the matter calmly and conservatively, the writer feels that time and money will be saved and that their reputation as engineers will be enhanced.

Salt Water Said to Preserve Wood Piles

In replacing a railroad trestle recently burned along the north shore of Great Salt Lake, engineers have just found that the piles are still perfectly sound after 43 years of service. Looking for the cause, since these were only of local pine and fir, they found the timbers impregnated throughout with salt from the lake. At another point on the lake, 18-inch piles, set 29 years, are similarly preserved with salt, which has penetrated to their very centre. Timbers in the Southern Pacific trestles across Salt Lake, placed in 1902, appeared to be as good as on the day when the piles were driven. They have been preserved well above the water line by the salt dashed onto them by the waves, a fact apparently anticipated by the engineers who built the trestles. It is pointed out that the reason why the waters of Salt Lake act as a strong preservative, as distinguished from ocean waters, is because the lake water is so much more salty—being practically a saturate solution. Preservation with salt is of no use in ocean piling against the attacks of teredoes and other marine borers. Experts in the forest service who have been investigating the preservative treatment of timber offer the suggestion that ties and poles which have been immersed for some time in the waters of the lake ought to be impervious to decay if the salt is not leached out by the action of the elements. It has been suggested that this can be guarded against, for example, by painting the butt of the pole with a coat of creosote which will keep out the moisture and keep in the salt.

A Feat in Bridge Construction

A notable engineering feat has been performed at Sibley, Mo., by the Atchison, Topeka, and Santa Fe Railway, which has built a new bridge over the Missouri on the piers of an old one, and has worked the trains over the old and the new bridge without the delay of a single minute to traffic. The old Sibley bridge, built in 1884, was then thought capable of carrying the heaviest trains that could ever be used, but in twenty-five years its capacity was outgrown, and in thirty years some of the trains and locomotives became too heavy to pass over it with safety. The old bridge consisted of one 80 ft. deck girder, one deck truss 197.5 ft. long, three through trusses each 396 ft. long, one deck truss 247.5 ft. long, two deck trusses 172.5 ft. long, twenty-one viaduct spans each 60 ft. long, one deck girder 75 ft. long, one deck girder 20 ft. long, and twenty-one viaduct spans each 30 ft. long, making a total length of 4,043 ft. Its weight was 3,566 tons, or 7,132,000 lb. The length of the spans and trusses of the new bridge is practically the same except at the south end, where a new pier was built between the first and second piers, and two girders of 100 ft. each put in. The steel viaduct approach is 2,000 ft. long, the total length of the new bridge is 4,060 ft., and the weight is 9,953 tons, nearly three times as great as that of the old structure. All the piers were enlarged to support the increased weight of the structure by encasing them in wooden forms which were then filled with concrete, steel reinforcing being employed to bind the concrete to the old piers.

Before a job is settled it is important that executive organization for the work should be well considered. A change in superintendents while the job is under way makes for unsatisfactory conditions, higher labor cost and inefficiency in general.

Concrete reflectors are to be used in the lock chambers of the Pedro Miguel Lock of the Panama Canal in preference to enamelled steel reflectors, the choice being determined by the lower price of the former, by the more suitable light distribution effected, and by the restricted headroom which prevents the use of projecting fittings. The reflecting surfaces are of white enamelled concrete, and for overhead use four-sided reflectors are adopted, while in walls a single plane inclined surface is employed. In side wall illumination the concrete reflector is grouted into a wall recess, leaving a front shade with a semi-circular opening at the bottom, which permits outward reflection of light, while preventing glare due to direct vision of the lamps.

To lessen the delay incurred in drying during the painting and repainting of rolling stock, which adds to the working expenses through vehicles standing idle, the Pennsylvania Railway have adopted what is called a paint oven. This is a double-skinned steel structure of the shape, but somewhat larger, of the largest vehicle on the line, and with one end opening. Into this the freshly painted car is run, the space between the two skins being heated by steam up to a temperature of 250 deg. Fah. There are upwards of 2,000 square feet of heating surface, and it is stated that not only is there much time saved, but the paint so treated exhibits an improved finish. It is obvious that modifications of such a system might be applied to many painted surfaces other than those of rolling stock.

In a recent address to the Manchester section of the Institution of Electrical Engineers, Professor E. W. Marchant reviewed the fields of employment open to the electrical engineer and the financial prospects which they afford. In his opinion electrical engineers are, as a rule, sadly underpaid, and as a result the industry is failing to attract the best men. One cause of this condition of affairs is to be found in the very large supply of capable and skilled men carried by every works of any size, and the comparative difficulty of an engineer, whether electrical or mechanical, in climbing out of his field into another which offers better prospects. Setting up for himself means consulting, agency work, or starting a works. Consulting is attractive in itself, but for well-known reasons offers scope in a limited number of cases only; agency work is obviously limited, but not without some plums; whilst the setting up of a works is impossible to most for lack of capital. Thus there is a tremendous competition of fairly capable men for all posts above a mechanic's wage, and employers, who usually look at the price of a man rather than his value, buy in the cheapest market.

Self-Purification and Care of Water Stored for Public Supply Purposes

THE advantages of the reservoir storage of water are many and the disadvantages are few. Formerly the expression "stagnant water" carried with it many ill-defined fears. It is now well known that still water rather than running water purifies itself the better. The greater the velocity of a stream the sooner is its pollution delivered to the consumer. Much more depends, therefore, upon the time of flow than upon the distance traversed between the point at which withdrawal of water is made. The following discussion of the self-purification of stored waters and the care of such waters when intended for public use is abstracted by Engineering and Contracting from an address by Dr. Wm. P. Mason, professor of chemistry at the Rensselaer Polytechnic Institute, before the Franklin Institute. Under the heading of the care of stored waters the use of copper sulphate for the removal of algal growths is discussed and data on the amount of the material needed and the amount which can be safely used are given. The portion of Dr. Mason's paper which relates to the patrol of watersheds is omitted from this abstract.

Stagnation has its disadvantages, of course. Increase in color naturally follows if water be permitted long to remain in contact with a muddy bottom loaded with soluble extractive matters. Not only is damage to the water's physical appearance a result of such contact, but the material passing into solution is likely to furnish abundant food for those minute forms of life which carry objectionable tastes and smells to many public waters.

One condition of "standing water," namely, that of being overstocked with vegetable growths, is practically the only one toward which objection can point when considering the pros and cons of reservoir storage.

The word "vegetable" is here to be taken in its broad sense, as it should include not only those growths which would be recognized by the public at large, but also those of the minute world as well, which latter constitute one branch of that lake life known as "plankton."

As an instance of excessive overgrowth, a small lake could be named which is so loaded with dense vegetation that decay gets ahead of new growth, and the use of its water is productive of temporary diarrhoea. It is a stained water, but its color is not to be considered as a measure of its objectionable qualities for table use, as many waters of much darker tint are of excellent quality for such purpose. Color and fitness for drinking bear no relation to each other.

It is true that colorless waters are now demanded by the people, and "meadow teas" are growing in disfavor, but that change in public opinion is of recent date and is not based upon established hygienic grounds.

The deepening in color of the lower layers of a water stored upon an unclean bottom; the encouragement of growths of small organisms producing taste and smell by reason of an accumulation of extracted food suitable for their development; and a deficiency is dissolved oxygen in the bottom levels, constitute the sum of objections that can be raised to the impounding of water, and they are much more than balanced by the advantages that accrue from such storage.

The pollution from shore drainage that reaches a reservoir water is likely to be naturally much smaller in quantity than that received by a flowing stream; nevertheless, very serious pollution may occur in concentrated form, even when the efforts of the caretaker are the most earnest. Thus, the writer has seen numerous loads of stable manure spread upon the very steep banks of a small, cup-shaped distributing reservoir. The intention in this case was good, and much pride was taken in the fine lawns of the waterworks park, but a better choice of fertilizer could have been made for such a location. It is entirely possible to protect a reservoir, and to a great degree the water-shed also, if careful policing of the district be established.

When meadow lands are flooded, the extraction of food for plankton growth must of necessity take place, and we are forced to choose between stripping the proposed bottom or else depending upon the employment of some means of killing or removing the organisms that are likely to develop.

As to what could be done to rid a water of the odors due to algal and other growths, the outlook was not very hopeful previous to the appearance of the "copper sulphate process" proposed by Moore and Kellerman in 1904.

The method of applying this chemical is simple enough, and its use is very efficacious. Bought in bulk, it can be had at about 5 cts. per pound, and its distribution is readily secured by filling it into perforated buckets, or even bags, and towing the same by rowboat or launch over the reservoir surface.

Decided objection was raised against such a process of "disinfecting" a public water supply, and the opposition was especially marked in England, but the use of it is still with us and is likely to stay, for the reason that the "dose" is minute and is only occasionally required, that it is reliable in results, and that experiment has shown that it is not followed by the evil consequences predicted.

It must be remembered that it is not added to the water continually but is used only at stated and widely separated intervals, namely, at those times when the "crop" of minute organisms has become so well grown as to produce objectionable effect upon the water.

Perhaps one reason why the "coppering" of reservoirs has led to so much criticism is because of the dead fish that are to be seen after the chemical has been applied. When considering this effect upon fish life, one should bear in mind that the "dose" has of necessity to be applied uniformly over the surface of the water, and each acre of such surface presumably receives the same amount, irrespective of the depth of water that the acre covers. As a result, the shallow parts of the lake receive temporarily a greater quantity of the sulphate, per cubic foot of water, than do those which are deeper; again, the entire quantity of chemical intended for the whole body of the lake is delivered to a few inches of its surface layer; therefore, until diffusion has taken place, fish which chance to swim into such water receive a very concentrated dose and are likely to be affected by it. Distribution is complete by the time the water reaches the public mains, and, moreover, the minute dose used has been more or less completely disposed of through its action upon the organisms for whose destruction it has been employed.

In a paper before the Section of Hygiene of the Eighth International Congress of Applied Chemistry, 1912, Kellerman presented the data given in Table I. on the required amount of copper sulphates.

TABLE I.—QUANTITY OF COPPER SULPHATE REQUIRED TO KILL VARIOUS FORMS OF ODOR-PRODUCING ORGANISMS.

Copper Sulphate Required, Expressed as Parts per Million Parts of Water.

Anabaena	.09
Asterionella	.1
Beggiatoa	5.
Chara	.2 to 5.
Cladophora	1.
Cladothrix	.2
Clathrocystis	.1
Coelosphaerium	.3
Conferva	.4 to 2.
Euglena	1.
Fragilaria	.25
Hydrodictyon	.1
Kirchneriella	5. to 10.
Leptomitus	.4
Microspora	.4
Navicula	.07
Oscillatoria	1. to .4
Peridinium	2.
Scenedesmus	5. to 10.
Spirogyra	.05 to .3
Ulothrix	.2
Uroglena	.05
Volvox	.25
Zygnema	.7

He adds a list of twelve genera of algae that in his experience are causing trouble in reservoirs and ponds:

Number of Observed Cases.

Anabaena	27	Conferva	56
Asterionella	9	Crenothrix	13
Beggiatoa	20	Fragilaria	19
Chara	26	Oscillatoria	49
Cladophora	17	Navicula	21
Clathrocystis	23	Spirogyra	43

Jackson claims that blue-green algae will die if the water be "coppered" one part to five million. His dose for Mellosira or Synedra is one to two million, and he claims that the former gives no odor of growth, but only that of decay. He finds that coppering runs out certain forms of organisms and substitutes others by a sort of selective action, but those thus substituted are not likely to be odor-producers; and he further notes that, while "bottom" or decomposition odors are easily shaken out by aeration, "top" odors, viz., those of growth, have to be removed by filtering out the organism, or killing them by copper sulphate, or both. In his opinion, filtration of either type is effective for removal of odors of growth, but he believes that aeration would be worse than useless for living plankton, for the reason that the agitation would tend mechanically to release the oil causing the taste, which oil is not very easily oxidized.

Naturally the cost of treatment with sulphate of copper will depend in part upon the amount of the chemical that is to be used, which in turn is determined by the kind of organism that it is intended to kill; but it may be said that a mixed growth of Mellosira and Asterionella was removed from the Troy reservoir at an expenditure of 14.9 cts. per 1,000,000 parts of water treated, labor included. The dose was one part of copper sulphate to 3,500,000 parts of water by weight.

In the article by Kellerman above quoted there are figures given indicating the safe limit for treating water with copper sulphate when certain fish are to be protected.

Copper Sulphate, Expressed as Parts per Million Parts of Water.

Black bass	2.1	Perch	.75
Carp	.3	Pickerel	.4
		Suckers	.3
Catfish	.4	Sunfish	1.2
Goldfish	.5	Trout	.14

It must be noted that these figures assume a thorough mixing of the sulphate solution with the whole body of water. They would not hold for the unequal distribution and resulting local concentrations already mentioned.

In some reservoirs which have been formed by the extensive flooding of swamp bottoms there may develop objectionable growths of crenothrix, a general term denoting an aquatic plant which at times gives much trouble because of its tendency to develop in the street mains and clog the pipes. It is often discovered quite unexpectedly, being dislodged by the current attending hydrant flushing or by the draft caused by fire engines. Dead ends are spots likely to harbor it, and its long rusty filaments have been mistaken for horse manure.

There are three types of the growth, each possessing the peculiarity of precipitating from the water in which it grows its own particular metallic hydroxide. By far the commonest of the three is Crenothrix Kuhniana, which demands iron for its development and which deposits large amounts of iron hydroxide as the result of its growth. The iron required for growth must be in solution, and the quantity demanded would seem to be about 0.3 part of iron per million.

In order that the iron may be in solution, we naturally would expect the dissolved oxygen to be low and the quantity of reducing agents, such as organic materials, to be high, and those are the conditions that we find in practice to be favorable to the development of the plant.

It is likely to be encountered in waters from swampy, peaty sources where dissolved oxygen is scanty and where the necessary iron in solution may be had. Driven wells in such localities frequently furnish it. Darkness favors its growth, and its development in city water-mains is often excessive, resulting in a material reduction of the carrying capacity of the pipes. The writer has some doubt about the "manganese" variety of Crenothrix being as rare as some think it is, he having found large quantities of manganese in a heavy Wisconsin growth. Beythien and others have, moreover, noted that the presence of manganese in water directly favors the growth of the ordinary form of Crenothrix.

Beyond the mechanical stopping of street-pipes, Crenothrix is exceedingly objectionable to the laundry interests of the community, for the reason that its rusty filaments cause "iron stains" to appear upon white linen.

Removal of the iron by oxidation and filtration is the best guard against troubles due to Crenothrix.

It must not be sweepingly assumed that all the "plankton" life is to be rated as uniformly objectionable; quite the contrary, as a reasonable degree of it acts as a distinct help in maintaining the safety of natural waters. Thus we find "bacteria eaters," such as many kinds of ciliated infusora, rotifiers, dophnia and the like, feeding upon minute germ life, and doing so to our great advantage.

Reservoir Stripping

With a view to avoid the troubles arising from the undue growth of odor producing organisms the stripping of the bottom and sides of reservoirs below the water line and the removal of a portion of the upper soil has been advocated and carried into practice. This, of course, entails very great expense when the surface to be stripped is at all extensive. At Columbus, Ohio, such work cost $159 per acre. In view of the expense of such treatment for larger reservoirs the question, "Does it pay?" is pertinent.

For the sake of general appearances, if for no other reason, trees, shrubs and bushes should be removed. Dead, standing timber and fallen logs are most unsightly and are very likely to produce complaint from the visiting public. In other words, the reservoir site should be cleared and grubbed, with, of course, entire removal of every vestige of human habitation; but beyond that it scarcely pays to go. The portion of the flooded land lying between high-water and low-water marks should receive especial attention, for the reason that during the periods of its exposure it is capable, if uncared for, of presenting an unpleasant appearance and provoking adverse criticism; with the further objection that heavy weed growth may develop if it be long uncovered, which growth will contribute toward the production of taste and smell when the water again covers it.

In an instance where it was proposed to restore a dam that had been out of repair for over fifty years, the writer advocated the cutting off of the standing dead timber at the existing water level before closing the breach, in order to insure a better looking sheet of water when the reservoir filled. This was for appearances only, as all extractive matter had been leached out of the old vegetation long before.

Aeration, filtration, and the judicious, occasional use of copper sulphate constitute the process at our disposal for combating the annoyance arising from algal growths, and their use will give greater satisfaction than the expensive stripping of reservoir bottoms, a treatment which was so frequently advocated in the past.

Purification in Storage

Dr. A. C. Houston, of the London Metropolitan Water Board, has undertaken some very extended researches upon the question of water purification as a result of storage. He found that in stored Thames water the death of typhoid bacteria took place rapidly, although the rate varied with the temperature of the water. In cold water they lived longer than in warm. and 50 deg. F. seemed to be a critical point above which their mortality rate was much increased.

In his 7th Research Report, Houston states that typhoid bacilli lived in stored raw Thames water for the following lengths of time: At 32 deg. F., five weeks; at 41 deg. F., four weeks; at 50 deg. F., three weeks; at 64 deg. F., two weeks.

Even these figures do not tell the entire story. Put in more detail they read:

	At start	One wk.	Two wks.	Three wks.	Four wks.	Five wks.
32° F.	103,328	47,766	980	65	34	3
41° F.	103,328	14,894	26	6	3	..
50° F.	103,328	69	14	3	..	..
64° F.	103,328	39	3	..	..	..

He concludes: "It is difficult to escape the belief that thirty days' storage of river water is tantamount to sterilization, so far as the microbes associated with water-borne epidemic disease are concerned."

Dr. Houston adds: "I am well satisfied that a well-stored, rapidly filtered water is likely to be safer than an unstored, slowly filtered water."

Although Dr. Houston is doubtless sound in his judgment that a great measure of safety will result from four weeks' reservoir storage of a polluted water, yet we must be assured that the period of storage is real and not simply apparent; or, in other words, we must know that all of the water really does remain in the reservoir for the specified length of time before it is used for public consumption.

Where the inlet and outlet of a reservoir are near together, as is not uncommonly the case, it makes but little difference what the capacity of the total storage may be; the water simply slips in and out again with practically as little stay as though the reservoir was a standpipe.

If the lake be long, narrow and deep, and all of its water be obliged to traverse its entire length before being taken for supply, then the conditions would appear ideal for purification of the inflowing water before the outlet was reached, and yet even under those excellent conditions it is possible to have introduced unexpected and upsetting factors, unless the watershed is regularly patrolled and inspected.

Disintegration of concrete and corrosion of reinforcing metal was the subject of a report of the Masonry Committee of the American Railway Engineering Association presented at the recent annual meeting. Four conclusions, detailed in the report, are as follows: (1) That concrete exposed to the action of sea or alkali waters or gases containing sulphur, or in which reinforcing metal is embedded, should be dense and rich in Portland cement and should be allowed to harden under favorable conditions; (2) that concrete in contact with alkali waters should be made with aggregates inert to the alkalies in the water; (3) that cinders should not be used for concrete in which reinforcing metal is embedded, and (4) that reinforcing metal should not be painted, but should be thoroughly covered and protected with concrete when in place.

An interesting installation of a plant for the filtration and purification of the water used for the miners' shower baths has recently been carried out at the Mariemont-Bascoup collieries in Belgium. The water contains carbonate of lime, as well as other lime salts, magnesia salts, carbonate of soda, and certain impurities in suspension, to remove which it is subjected to the action of a solution of lime water and one of sulphate of iron. The plant comprises three main components, one which automatically proportions the quantity of lime water to the impure water to be treated, the second for the preparation of the lime water, and the third in which the softening and filtration is effected. The water as it is filtered is also aerated, provision being made in the filtering chamber for a strong current of air to be drawn in with the water. The plant has been in use for over six months, during which time it has, it is stated, given every satisfaction. About 1,540 gallons of water per hour can be treated, the cost working out at approximately 8 cents per 220 gallons of filtered water.

Separate and Combined Sewers in their Relation to Sewage Disposal

By John H. Gregory, Consulting Engineer, New York City

IN the construction of a new sewerage system, or of new sewers, one of the problems which first arises is the question shall the sewers be built on the combined system, or partly on both. Two factors of the greatest importance are the questions of cost and of sewage disposal.

As a general proposition, where both sewage and storm water are to be removed it is probably safe to say that the cost of building a combined system is less than that of constructing a separate system, in which the sewage flows in one set, called sanitary sewers, and the storm water in another set, called storm water drains. This is especially true where the territory is more or less closely built up and the streets are paved. Built in territory, not closely built up nor likely to be in the near future, and where the storm water is easily diverted into natural water courses, the separate system will in general cost less, for the sanitary sewers may be built first, the storm water drains being deferred, or only such drains built as are immediately required.

Combined Sewers

The character of the topography should not be overlooked. With steep grades and relatively high velocities in the sewers it might prove more advisable, on account of the relatively small additional cost, to build combined rather than separate sewers. In narrow streets and in congested districts combined sewers have an advantage by reducing the sub-surface obstructions. With the separate system two pipes are required, and sometimes three, when a sanitary sewer is laid on each side of a storm water drain, built so close to the surface of the street as to prevent the carrying of house connections over it.

With the combined system, but one house connection is needed, whereas with the separate system, especially in closely built up districts with paved yards and areas, two are required, one for the removal of the sewage and the other for storm water from roofs, paved areas, etc. The practice of discharging storm water across the sidewalks to the gutters is not one to be recommended. The storm water is, however, sometimes removed by pipes laid just below the surface of the sidewalk and discharging at the gutter. Such pipes frequently give trouble, and often would not be low enough to drain paved areas adjacent to or in the rear of buildings.

Combined sewers are generally laid on flatter grades than separate sewers and may increase the area which can be served without pumping. They may even eliminate pumping entirely. It sometimes happens that combined sewers can be advantageously adopted for a part of the system and separate sewers for the remainder. The writer has in mind one of the large cities in the east where no pumping is required and in which three-quarters of the city is sewered on the separate system and one-quarter on the combined system because it was too low to be sewered on the separate system without pumping.

Higher velocities are required in combined sewers in order to prevent the deposition of grit. When deposits occur in combined sewers organic matter is likely to be held back and settle out or become stranded and may cause the sewage to be bonded and become stale, or possibly septic, a condition to be avoided, independent of whether the sewage is to be treated or not.

So far the subject has been considered without reference to the question of sewage disposal, one of the most important factors. If the sewage is to be discharged into a body of water without treatment, combined sewers would frequently offer the simplest and cheapest solution of the problem. If, however, the sewage is to be treated, separate sewers have certain advantages. It will be assumed here that the sewage must receive some treatment and that ample opportunity is afforded for the discharge of storm water without carrying any great distance.

Sewage treatment works cost money. It is therefore desirable to keep them as small as possible. Rarely, if ever, would all of the storm water have to be treated; hence the question of treating other than the first wash of the streets, in addition to the sewage, will not be considered.

With a separate system the volume to be handled at the treatment works is made up of house sewage, ground-water leakage and trade wastes. The flow may be increased in times of storm by taking in the first wash of the streets from the storm water drains should it be found necessary or desirable to treat the first wash.

With a combined system, under dry weather conditions, the volume to be handled ordinarily is also made up of house sewage, ground-water leakage and trade wastes. In times of storm, however, the flow in the combined sewers is increased by the storm water from the streets, which changes the character of the liquid flowing. The first wash from the streets is often exceedingly foul and may give a stronger sewage. As more storm water enters the organic content of the liquid is decreased, resulting in a weak or dilute sewage.

If only the dry weather flow is to be intercepted, then the volume to be handled at the treatment works would, in general, be substantially the same from the combined system as from the separate system. With the separate system no raw sewage escapes to the streams, while with the combined system a mixture of sewage and storm water must reach the streams.

It probably often would be the case, that as far as the temporary reduction of dissolved oxygen in the stream is concerned no harm would be done, but floating particles of paper and fecal matter are offensive to the sight. If the stream is sluggish it may easily be that the continued overflow of sewage into it, from time to time, with the accumulation of sludge deposits on the bottom, would lead to offensive conditions.

While considering the question of the overflow of raw sewage from combined sewers the point of view of the public should not be overlooked. They know that the sewage must be treated and their natural inference is that all of the sewage will be treated. But if the sewers are built on the combined system and the public sees raw sewage, even if dilute, discharged into the streams from time to time will they be satisfied? And will the state authorities be satisfied?

In order to reduce the number of times during the year that raw sewage would overflow, it might be planned to intercept some storm water as well as the dry weather flow. This would increase the size of the sewage treatment works, and their cost.

If it is found desirable or necessary to intercept and treat the first wash from the streets, the separate system is more advantageous than the combined system, as by its adoption no overflow of raw sewage to the streams will take place. The storm water drains receive only storm water and the first wash from the streets can be intercepted in the storm water drains and discharged either into the sanitary sewers, or into the intercepting sewer leading to the treatment works. As the flow in the storm water drains increases, the surplus water overflows to the streams but carries no sewage with it.

Separate System More Flexible

The separate system, under certain conditions, offers greater flexibility in the disposal of trade wastes than does the combined system, unless the first wash of the streets is to be intercepted and treated. Some trade wastes are offensive and if discharged into the sewers in such a condition must be treated. Some are inoffensive and can be discharged directly into the streams without causing any nuisance or trouble.

With the separate system the offensive trade wastes can be discharged into the sanitary sewers and the inoffensive wastes into the storm water drains. The offensive trade wastes only would then be carried to the treatment works. With the combined system all of the trade wastes, the inoffensive as well as the offensive ones, would have to be intercepted and carried to the treatment works, with the result that the treatment works would have to be somewhat larger in size, and hence would cost more.

With a combined system automatic regulators are generally used on the connections between the combined sewers and the intercepting sewer to limit the amount of flow from the combined sewers to the intercepting sewer. With a separate system automatic regulators are not required unless the first wash from the streets is intercepted in the storm water drains. Automatic devices in sewers, as a general proposition, no matter how well designed, are to be avoided wherever possible.

The presence of grit at a sewage disposal works is generally more or less of an annoyance, especially when the sewage has to be pumped and passed through settling tanks. With combined sewers, receiving as they do storm water from the streets, a considerable amount of grit must be expected to reach the disposal works, not only during wet weather but during dry weather also. With separate sewers the amount of grit received at the disposal works is relatively small unless the first wash from the streets is intercepted in the storm water drains and carried to the disposal works.

Sand-Catchers

It has been suggested that a considerable amount of grit could be prevented from reaching the disposal works from combined sewers by inserting a catch basin or sand catcher on each connection between the combined sewers and the intercepting sewer. It is probably true that such would be the case but it is a question whether this would be a good method of removing grit. In the first place these sand catchers would sooner or later fill up and unless cleaned at proper intervals would fail to serve the purpose for which they were built. Again, it is very probable that more or less organic matter would be deposited in them, especially when only the dry weather flow, consisting as it would mainly of sewage, was passing through them.

The inserting of sand catchers between storm water drains and an intercepting sewer would seem to be a more practicable proposition. They would still have to be cleaned to make them effective.

It is a question if the simplest way of handling the grit is not to admit it into the intercepting sewer from the combined sewers or storm water drains, without attempting to intercept any portion of it, and then to transport it with a good velocity in the intercepting sewer direct to the sewage disposal works. In any event enough grit is sure to reach the sewage disposal works to require its removal before the sewage is pumped or passed through settling tanks, and the removal of grit at one point instead of at numerous points has many advantages.

With sewage from a combined system the volume of sludge accumulating in settling tanks is greater than with sewage from the separate system. It may even be nearly twice as much, as has been found to be the case by comparison of the quantities of digested sludge removed from different Imhoff tanks, some of which have been connected with combined systems and others with separate systems. The greater volume of sludge from the combined system may mean that less organic matter has reached the streams than would have been the case if the sewers had been built on the separate system. If, however, the first wash from the storm water drains of a separate system is intercepted and carried to the treatment works then the volume of sludge should be approximately the same as if the sewage came from a combined system.

When Sewage Must Be Pumped

In many instances pumping is required in order to pass sewage through a treatment works. It may even be that the sewage would be delivered at an elevation below that of the stream into which the effluent was to be discharged.

With a combined system the total height to which the sewage would have to be pumped would probably be somewhat less than with a separate system, but the difference would not be great. Some saving in fuel might therefore result from the adoption of the combined system, but the same operating force would be required in either case. So long as pumping is required the actual saving in cost due to pumping the sewage against a less head, due to the adoption of the combined system, would be slight compared with the total cost of pumping, including fixed charges.

In conclusion no hard or fast rules can be given for the adoption of either the combined or the separate system. Each has certain advantages. These, as well as local conditions and cost of construction and operation, must be taken into account. Other things being equal, especially as more attention is being given to the question of sewage disposal, the separate system seems to offer greater advantages. With either system, however, to secure satisfactory results too much stress cannot be laid on the necessity of not only proper design, but satisfactory maintenance and operation.

Possibilities of the Nail-Head as a Decorative Medium

NAIL-HEAD decoration—mainly in geometrical form, as studding, etc., to doors—has been largely used in work of the Early English and Decorated periods, but it is very seldom seen in modern work of any description, says the writer of an interesting article in The Building News. No doubt this is mainly due to lack of sufficient consideration of its qualities as a relief or decorative factor. It is certainly worth while calling attention to its possibilities as an inexpensive medium, ready to hand, for a large amount of simple relief possessed of a decided character and beauty of its own. It has the further recommendation of being readily applied in many positions where more expensive methods of decoration would not be considered. Simple, slightly-cut post-heads, for instance, to garden-gates, entrances, palings, etc., can be given a really large amount of decorative finish by the careful disposition of a little nailwork in a studied scheme of design. Geometrical patterns picked out in small nails, with medium and large sizes introduced in judicious positions as auxiliaries to give a more emphasized and varied relief to certain portions, forms a very attractive method—something after the style indicated by Fig. 1. In oak wood especially the nailhead has a remarkably good appearance. A a medium also for the introduction of ornamental lettering or figures it is certainly difficult to rival for picturesque effect. Utilized in this method, it is preferably worked on the diagonal, with small circular nails between, or small square-headed ones, placed on the square. Slight graduations, by different sizes, towards the thickening of letters or figures forms a still further improvement, as illustrated by the date-panels in Fig. 2. Square oak slips about 2 in. or so by ⅛ in. in thickness can be introduced diagonally, either singly or grouped, and secured by a nail in the centre. With smaller ones between, or indicating corners of a design such as shown by the first example of this figure, it forms another simple but pleasing method of relief with this style of ornament. Square, octagonal, or pointed panels can be formed as well by narrow slips, tacked on, surrounding the letters or figures, as indicated by the combination date-panel, Fig. 3. Monograms are also readily introduced to many other positions besides that shown by the succeeding figure, No. 4. More pronounced and decided designs are produced by the adoption, in various cut shapes, of a larger overslip nailed to the post-heads, etc., as illustrated by Fig. 5. A further simple but very suitable combination in the form of an overslip, with the nail-head, is that provided by a small fret panel. Either used as a bold, simple, and central design shown by Fig. 6, or in finer and more detailed patterns, which might often be adopted for many suitable positions. The small design for a garden-gate and railings, Fig. 7, illustrates more clearly the use of the nail-head and slip in general design of a simple character. Such as might be well applied for the entrance to a small house or cottage. Panels, suitably designed, placed either on the gate or upon broader posts, might have the name or number indicated by the same methods. Another very good position for such applied decoration is the door itself, when not too far back. This might also be introduced, either by names, numbers, or a little suitably-applied pattern-work here and there. These positions, however, form by no means the end of the nail-head's possibilities as a decorative factor. There are plenty of other opportunities for its satisfactory introduction in many positions. For instance, the simple narrow slip and nail-head work, very sparingly used, as shown by the porch design in Fig. 8, illustrates further possibilities in quite a fresh manner. It dispenses entirely with the customary stereotyped panelling and moulding usually employed. It is thus possible to erect something of a very different nature to that which is more often tacked on to a building as a mere excrescence, somewhat in the shape of a porch. The example as indicated has a large amount of Doric feeling introduced by the simplest, yet most inexpensive methods. The slips have much the appearance of triglyphs from a distance, whilst the large nail-heads under take the place of metopes. A further extension of this system is that of strapwork design, applied on the same principle. This is illustrated by the small design, Fig. 9. Another departure is illustrated by Fig. 10, simple cut-out panels being formed, and spiked on the face with good nail-heads showing in set positions. The panels to the pilaster portion of frieze are cut shield-shape, with diagonal lines of nail-heads. The spandrels may be formed either by cut-out frets, as indicated, or solid spandrel-pieces might be cut out and nailed in position as raised panels. This short article merely comprises a few systems. The possibility of considerable extension to this class of work in many other directions should be quite clear. At the same time, it forms a pleasing relief from much-overworked ornament decidedly stereotyped in character. It should be quite apparent that the nail-head can be made a very pleasing medium of ornamentation, both artistic and picturesque, as well as practical.

According to a contemporary, great difficulty is being found in getting satisfactory strength in the immense chains now under construction at the Boston Navy Yard for the lock-gate protection of the Panama Canal. These chains and their hydraulic operating machinery are an innovation in canal lock design and operation. They are designed to be stretched across the locks in front of vessels to arrest the momentum of a ship which, for any reason, gets beyond the control of the electric towing locomotives. The chains are made of 3-in. diameter wrought iron; the links are 17-in. long by 10¾-in. wide. The twenty-four chains necessary have an average length of 427 ft. each, and weigh 85 lb. per foot. Great differences in the strength of different links have been found, mostly in the welds where the breaks in the chains tested generally occur. All links are tested to about 275,000 lb. The breaking loads have run from 312,000 lb. to 560,000 lb. Open links appear to be stronger than stud links, in general, but they elongate much more. The parts of the chain which will run over the sheaves of the hydraulic operating machines have open links, while the parts which will span the locks have stud links.

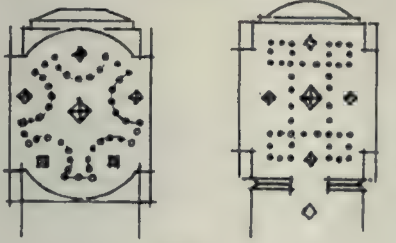


Fig. 1

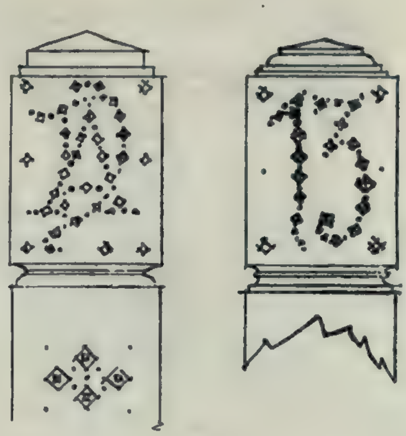


Fig. 2

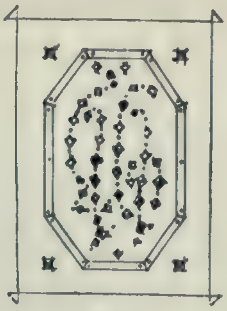


Fig. 3

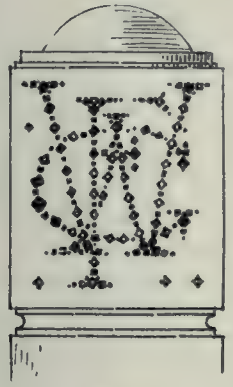


Fig. 4

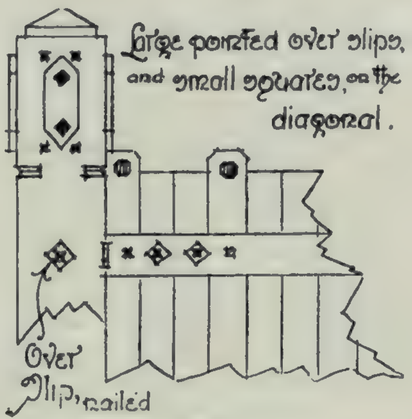

Large pointed over slips, and small squares, on the diagonal.
Over Slip, nailed

Fig. 5

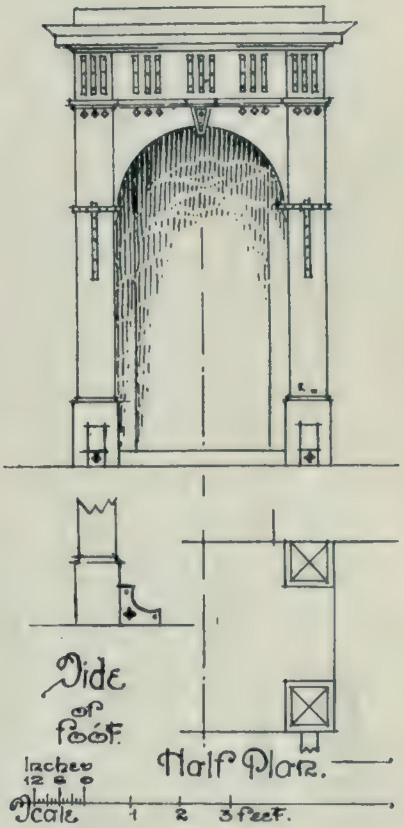


Fig. 8

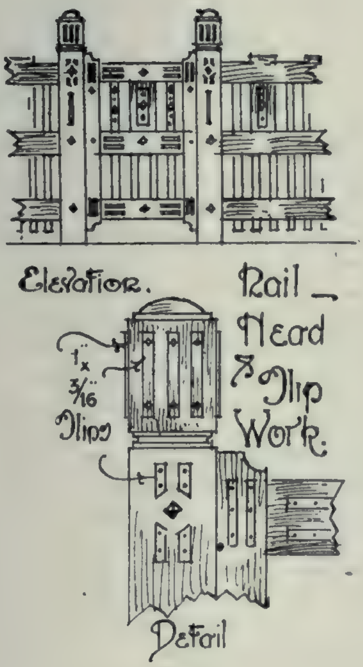


Fig. 7

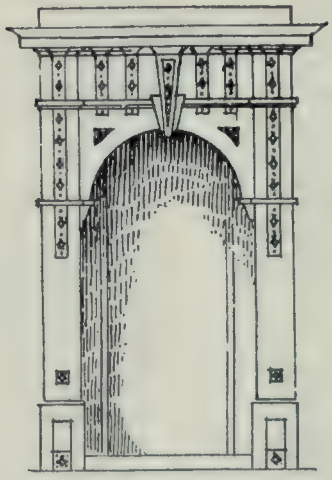


Fig. 9

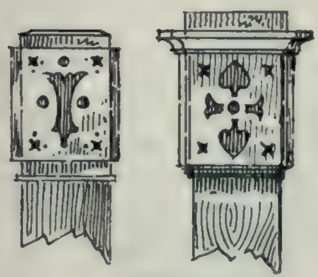


Fig. 6

The Nail-Head
as a
Decorative Medium

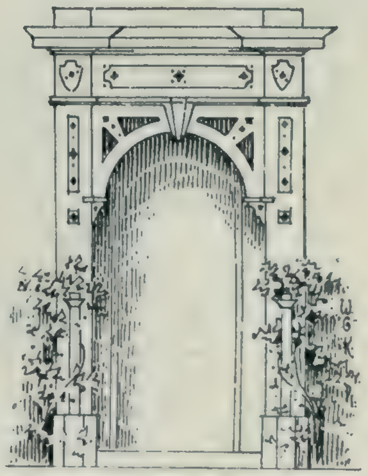


Fig. 10

The Part of the Architect in Structural Engineering*

By W. E. Brown, A. R. I. B. A.

STRUCTURAL engineering includes, not only steel work used in buildings, but also all forms of construction, whether in brick, stone, timber or concrete, and in designing buildings and other structures the architect is called upon, not only to exercise his artistic ability, but also so to plan and arrange the various materials to carry safely, in addition to their own weight, all superimposed loads and forces, so that the whole may remain perfectly stable.

The Architect to Determine Positions of all Steel Work

It is the architect, and the architect alone, who should determine the positions of all main girders, stanchions and supports. In many buildings it is impossible to proceed with the design until these positions are determined. In some cases it is the roof which is the determining factor in planning a building—whether the spans shall run from north to south or east to west. In others it would be such a feature as a dome; for example, how could Wren have planned St. Paul's unless he knew beforehand how he was going to support that great and glorious crowning feature of his design? That building could not have been erected had Wren simply made a drawing and handed over the structural work to somebody else to deal with; or had that course been adopted, the resulting design would have been different to that made by the architect.

In a case of rebuilding, which was placed in our hands to carry through, owing to difficulties having arisen after the contract was started, on going through the plans and steelwork drawings I was able to effect considerable economies in the building and also the steel work—in the latter amounting to over ten per cent.—simply by the addition of two stanchions, which eliminated some heavy riveted girders. This was a glaring example of the result of not employing an architect to design the premises in the first instance.

Necessary Information to be given to Engineers When Obtaining Estimates

A good deal of stress has been laid on the question whether the steelwork should be designed, and quantities taken out by a consulting engineer, before being sent out to the constructional firms for estimates, or whether these firms should be allowed to do the calculations themselves. For contracts involving a large amount of steelwork of a complicated nature, I agree that a consulting engineer should be appointed by the architect, but there are many smaller works where this is not necessary, nor would the outlay on the building work warrant the expense incurred. It is quite satisfactory, given certain conditions laid down, to which I shall presently refer, for the architect to send the drawings to several firms of engineers, and let them make their own calculations and quantities; but to enable the various contractors to estimate on the same basis, the following information must be given to each:

(1) Plans of all floors showing the lines of all main girders and the positions of stanchions and columns; also a section or sections and outline elevations must be given.

(2) The loads that each floor has to carry and whether live or total loads.

(3) Whether price is to include for hoisting and fixing, or only for steelwork delivered to site.

(4) If it is to be delivered unpainted, painted or oiled, and if painted with what materials, and that all scale and rust must first be removed.

(5) Workmanship, whether connections are to be rivetted or bolted, and if the latter whether ordinary bolts will be allowed.

(6) Whether the price is to include 10 per cent. profit for the builders or only 2½ per cent. cash discount. My own practice is to state the latter.

Reinforced Concrete

I should just like to touch upon reinforced concrete. This is an excellent method of construction, but the serious drawback to it is what I may term the "human element." Very careful and constant supervision is necessary, or something may go wrong. It is for this reason that I have not employed this method of construction to any large extent, my experience not being a very happy one, and you may be interested in hearing something about it. After a good deal of consideration I decided to put in a reinforced concrete floor and roof over a garage, some of the spans being over 21 ft. Estimates were invited from two specialist firms, the conditions being that the R.I.B.A. regulations and stresses should be adhered to. As regards price, there was not much difference between the two, and no details of construction were submitted with the estimates. When the matter was discussed with the respective engineers I found that, in one case, fixed ends were calculated for where the floor was let into the wall about 3 in., and also where the rods were anchored to steel joists over window openings. I do not agree with such a theory, and so that estimate was rejected. The other engineer satisfied me on these and other points, and agreed to supply me with details and copies of the calculations if the estimate was accepted. He also referred me to several large contracts which his firm had completed.

The estimate was accepted and the work started, but, although applied for, no details or calculations were submitted. In the meantime one bay was put in, the rods being inserted haphazard from 1 in. to 2½ in. from the bottom of the slab. I took particulars and worked out the stresses, assuming the steel to be 1 in. from the bottom, and found the steel stressed to nearly 25,000 lb. per square inch and the concrete (4:2:1) 1250 lb. per square inch. I immediately wrote stopping the job, and received a visit from their chief engineer, who brought a small slip of paper with some calculations showing 20,000 lb. stress in the steel and 750 lb. in the concrete. I adhered to my figures, which he borrowed for further consideration, the end being that I received a visit from an eminent consulting engineer—a member of this Institute—who accepted my figures and came to ask what was to be done. To cut a long story short, the floor was taken out and new floor put in of a greater depth with additional reinforcement.

---

*Abstract of a paper read at a recent meeting of the Concrete Institute (London, Eng).

The trouble, however, did not end here, as I found the bars over the entrances, which were 32 ft. wide, being put in without any support under the ends. What would have happened had this not been discovered in time, I leave you to guess.

When I tell you that I have seen specialist firms' own men sawing up timber for centering and the sawdust and shavings and small pieces of wood all left and mixed up with the concrete, I think one's faith in trusting to such people is rudely shaken. One requires a good Clerk of Works, well up in reinforced concrete construction, with several smart assistants under him, to look after the work. For small jobs this would be too expensive, and in my own work I have gone back to small steel joists and concrete. The general contractor is competent to carry out this work, and one does not have the delay and friction between contractor and sub-contractor which so often takes place.

Here let me utter a warning against using breeze for floors. There is a very great danger of expansion, and I know of several cases where this has occurred and pushed walls several inches out of upright, and even when the wall was rebuilt it happened again. There is also a corrosive action between the concrete and steel which in time may endanger the stability of the floor.

With regard to shear in reinforced concrete slabs and beams, I do not consider it wise to calculate for the concrete taking any part of the shear, although the R.I.B.A. regulations, and, I believe, those proposed by the London County Council, give 60 lb. per square inch as the allowable shear stress. My reason for this is that long before the reinforcement can be stressed up to 16,000 lb. per square inch the concrete below the neutral axis must be cracked in all directions. They may be very fine cracks, it is true, but for all that, in my opinion, the concrete has lost all its value to resist shear. The steel alone should therefore be calculated to resist the shear, and this does not involve a large amount of additional steel, as the tension rods can be turned up and used for this purpose, most of them not being required at the bearings to resist tension. For this reason it is advisable to use a number of small rods rather than a few of larger sectional area.

Expanded metal is an excellent form of reinforcement for slabs, and binds the whole of the concrete together. It would be interesting to know if the method of manufacture has any deleterious effect on the tensile strength of the steel, and whether, when the metal is fully stressed, there is any possibility of rupture where the strands bifurcate. I presume, in calculating the area of steel, when using expanded metal, that two strands would be taken for a width of slab equal to the mesh of the reinforcement.

In large beams and pillars there is often a difficulty in getting the reinforcement into the correct positions, and also in having the rods properly surrounded with concrete. I have seen several cases where the main rods project beyond the concrete, and to render the same up afterwards is not effective. Another important item to see to is that all of the rods, where they pass in connecting beams and pillars together, are surrounded with concrete. It is a difficult matter sometimes to do this, and considerable skill is required in arranging the rods in positions such as I have mentioned. As far as possible, I think that the reinforcement for all beams and pillars should be assembled on the ground and the rods securely wired together to keep them in their correct positions before being placed in the forms. There is less likelihood of the rods being displaced than there is if the rods are first laid in the forms and wired up afterwards.

It is also very important that all forms should be properly cleaned out before any concrete is put in, and the best way of doing this is by water and a hose-pipe.

Conclusion

These are only a few of the details that come within the purview of the architect, and I hope you have not been wearied by the reference to what many of you may consider to be minor matters in structural steel work, etc. I have refrained from touching upon calculations, which have been, and can be, more ably and fully dealt with by others whose every-day business is to deal with such matters, and who are consequently more competent to do so than myself. I hope, however, that some useful information on the several questions I have raised may be brought out in discussion. You will agree with me that it is in details that an otherwise good and sound scheme may prove deficient.

Why Brick Houses are Cheaper

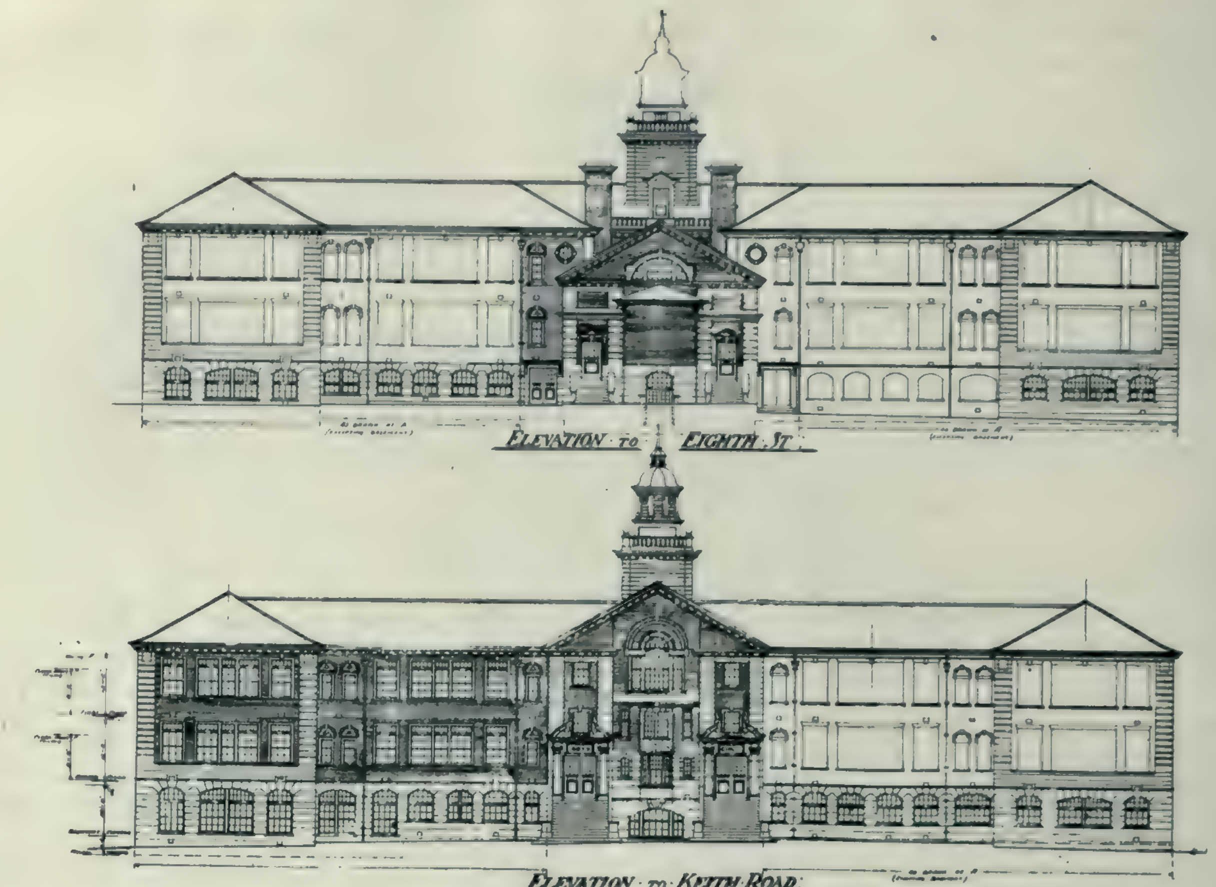
AN Indianapolis architect, who was recently asked by a prospective home builder why so large a number of small houses were being constructed with brick exteriors, instead of frame, as in the past, and questioning the economy of brick construction, made the following statement, reported by Brick and Clay Record:

"There is a belief in the minds of a great many people that brick construction costs from 40 to 50 per cent more than frame construction. Experience and investigation, however, have shown this belief to be a fallacy. The large number of brick residences that have been built during the last year have done much to establish the fact that brick is really the best material for the economical builder to use.

"An investigation of the costs of building materials with the aid of an architect will prove both interesting and instructive, especially when the brick construction is compared to the cost of frame construction. In frame construction, labor is employed in seven different instances, namely: (1) The studding, which forms the frame of the building; (2) the sheathing; (3) the building paper; (4) the weather boarding; (5) the lathing; (6) the plastering, and (7) the painting, which requires three coats to get good results. In brick construction, but two processes are necessary: (1) The brick work, and (2) the plastering.

"Carefully compiled statistics show that the actual cost of brick walls over frame varies from 15 to 40 per cent, depending largely on the price of the face brick selected. As the walls of any building cost only about 10 per cent of the total, brick construction would add only from 2 to 4 per cent to the total first cost of the building. As it is necessary to repaint a frame dwelling every few years, it will readily be seen that brick construction, besides being the best, is the cheapest. A building constructed of brick is much easier heated than a frame one, and the saving in fuel is an item to be considered. Also, it must not be forgotten that with the faces and shades of brick now being manufactured it is possible to build a handsomer building of brick than from any other material."

Sir William Van Horne, director of the C. P. R., is at present on a six weeks' trip to England.



Proposed Central School Building, North Vancouver.

Splendid New School for North Vancouver

TENDERS were taken last month for the proposed Central School building at North Vancouver for which Mr. W. C. F. Gillam, of Vancouver, is the architect. Work on the general contract was expected to be well under way by the middle of June. The building, which will cost $120,000, will occupy a large site bounded by Keith Road, Eighth Street, Mahon Avenue, and Chesterfield Avenue, and will measure 204 x 140 feet. It is to be fireproof, having two storeys and basement with sixteen class rooms and masters and teachers' rooms, manual training and domestic science rooms, sewing room, drill hall and gymnasium and a large auditorium measuring 88 x 35 feet, including a balcony with seating accommodation for about seven hundred people. The main constructional features comprise reinforced concrete frame, brick and tile walls with stone trimmings, interior tile partitions, slate roof, fir block wood floors, ventilating and steam heating system, up-to-date plumbing arrangements, electrical work and an inter-communicating telephone system.

Mr. Gillam, the designer, is a well-known expert in the field of school planning. One of his recent and most important works is the Provincial Normal School at Victoria, costing $400,000, a building which is rapidly approaching completion.

The Strength of Brickwork

IT is only natural that when a brick manufacturer has had the crushing strength of his bricks tested, he should be pleased to show to all likely customers a certificate to indicate the superiority of his bricks in this respect. It is equally right that architects engaged in the design of buildings intended to carry heavy loads, such as factories and some public buildings, should lay considerable stress on the necessity for the bricks showing a certain resistance to crushing. But of what real value are these tests? asks The Brickbuilder.

Most machine-made bricks will have a crushing strength of 2,800 pounds per square inch, and if reasonable care has been taken in their manufacture, a much higher strength is not uncommon. Engineering bricks may easily double this figure, and in some works the average crushing strength of the bricks is no less than 4,000 pounds per square inch.

When the bricks are built up into masonry, however, the structure will not safely stand a load of more than 100 pounds per square inch, and only with the best building bricks is a load of 210 pounds per square inch considered safe. This is due to the fact that the mortar used in laying the bricks is, in itself, far weaker than the bricks, and it only gains strength as it hardens. Yet various investigations of ancient buildings show that lime mortar seldom, if ever hardens completely in the interior of the joints, so that the weakness of brickwork is not due to the bricks, but to the imperfectly hardened mortar.

This drawback can be overcome by using cement and sand in place of lime and sand for the mortar, and, provided that the joints are kept thin, and the correct proportions of cement are used, this cement mortar will not prove more expensive than ordinary mortar. On the other hand, the strength of the brickwork will be increased many times, and a crushing strength of 3,800 pounds per square inch—corresponding to a safe load of 380 pounds per square inch—is not difficult to attain.

The use of cement mortar, therefore, provides the manufacturer of bricks with a means of showing how enormously strong structures may be made at prices to compete with the rivalry of concrete. If the matter is worked out carefully, it will be found that bricks at 27s. per thousand can be reinforced and laid in cement mortar at a cost which is well below that of concrete, provided that the building is one which will really give both materials a fair chance. Moreover, the brick building will have an admittedly better appearance than the concrete structure, and the chances of failure by electrolysis and other adventitious causes are much less. Hitherto most brick manufacturers have been content to accept the statements of other people that concrete is stronger than brickwork

One fact must be observed in the use of cement: It is very liable to form scum or whitewash unless the mortar is properly made, and this would disfigure the building, though even then it would not be worse in appearance than many of the concrete buildings now in existence. This scum may, however, be avoided by mixing some dust made by crushing soft, red bricks with the mortar, as this brick-dust combines with the lime set free from the cement, and not only increases the strength of the mortar, but also prevents any whitewash being formed. This method was known to the ancient Romans and Greeks, and was used by them in many of their most important buildings.

There is much to be done in the way of reinforced brickwork. The pity of it is that many brickmakers are content to see trade going into the hands of the concrete makers, whereas if they only took the pains to enlighten their local builders and architects as to the advantages of reinforced brickwork over concrete in most localities, there would soon be an increased demand for bricks.

In the course of an article in the Engineering Review, Mr. Ewart S. Andrews describes an interesting steel dome in the Wisconsin State Capitol at Madison, Wis. The dome and its supporting tower form a steel structure independent of the remainder of the building. The dome is 90 ft. in diameter at the base, and its summit is 236 ft. above the ground floor, which is taken as the datum level; above the dome rises a lantern to an elevation of 267 ft. Eight reinforced concrete piers are carried by four reinforced concrete footings, and the sixteen steel columns of the structure are embedded in pairs in these piers. These columns extend to a height of 78 ft., and are capped by plate girders forming a ring course, octagonal in plan, with alternate long and short sides. From this point at the top of the tower to the top of the lantern the superstructure was designed as a steel frame building. The weight of the whole dome and substructure is 30,000 tons, and this is carried by the four reinforced concrete foundation piers on footings 16 ft. thick, the pressure on the soil being 3½ tons per square foot. The weight of the steel work is 3,000 tons, of which 900 tons is carried in the substructure.

Moving Loads on Bridges

STRUCTURAL significance of moving loads on highway bridges, was the subject of a paper recently presented before the Western Society of Engineers, by Prof. F. O. Dufour, Assistant Professor of Structural Engineering in the University of Illinois. The paper was based on the carefully recorded results of tests and experiments, extending over several years, on highway bridges under moving loads. The bridges were located in Champaign and La Salle Counties, Illinois, and comprised through-truss spans of different lengths with different widths of roadway, and with flooring of either plank or reinforced concrete. Professor Dufour's conclusions are summarized as follows:

1. That built-up members are superior to single shapes.
2. That light loads produce the greatest percentage of impact, but that the light-load static stress, plus the light-load impact stress, does not exceed the static stress for which bridges are usually designed.
3. That reinforced-concrete-floor structures are much superior to the plank-floor structures.
4. That on account of the fact that the stresses produced by heavy loads in reinforced-concrete-floor structures are very small, the impact percentages were difficult to determine, and that the values given are probably far in excess of the actual, which appeared in the majority of cases to be zero.
5. That actual stresses in reinforced-concrete-floor bridges may be assumed as one-half the computed static loads.
6. That considering conclusions 1 to 5, we may safely neglect impact in reinforced-concrete-floor bridges, and that we may assume each joist to take 20 per cent of the wheel load or 10 per cent of the axle load.

The Modern Architect

THE Engineering Record, in a recent issue, discussing the complex duties of the practice of architecture to-day, states editorially: "Before passing hasty judgment upon the architect of our own times, think a moment of the evil days upon which he has fallen. In the mediaeval times he must perforce know only the technique of masonry—the rest was his art. If he were building a church the fine stimulus of the Gothic was his inspiration and his medium was craftsmanship in stone. To-day he must know masonry and concrete, structural steel and sanitary plumbing, lighting and heating, electric wiring and acoustics.

"His predecessor did not have to plan for buying his stone from one source; his steel from another and his woodwork from a third; he was not hounded by agents of patented devices nor pestered by circulars of supplies offering him 'the usual architect's commission of —— per cent.' All these things the architect of today has to endure, besides being called a slavish copyist if he turns to the best in antiquity and a commonplace innovator if he does not.

"His chief hope is in suiting himself as best he may to new conditions, calling in technical advisers on the details which he cannot in the nature of things have time to master, even if he has the ability, standing the more firmly by the interests of his client as he comforts a regiment of sub-contractors, and remembering that he must be artist before being engineer or contractor. Originality and resourcefulness are much more difficult to find than technical or constructional skill, and if the architect is to be more than a master mason or boss concrete mixer it must be by the possession of these attributes. Art did not die with the Gothic nor perish with the Romanesque. The times have changed and the architect must change with them.

The Bulk Handling of Cement[*]

By H. M. Capron[†]

THE use of cement in bulk is comparatively new. My experience with bulk cement started with the mechanical problems involved in handling and storing the material and other aggregates at the mixing plant, measuring and conveying them to the mixer, and mixing and handling concrete.

Some of the large cement companies, and a few progressive contractors, have been studying this problem recently. I am indebted for many ideas to Mr. Robert F. Hall, Assistant Sales Agent of the Universal Portland Cement Company, who has made a very careful study of the subject of handling cement in bulk.

Like all new ideas, its beneficiaries accept it reluctantly, and its advocates are subject to the criticism which greets all pioneers. It is remarkable of human nature that the people who are most benefited by a new idea are the slowest to adopt it; and it is equally significant that once a contractor has used bulk cement, he becomes one of its most enthusiastic converts. It requires no little originality, and a great deal of courage, to depart from a custom of years' standing in any line of business, and such departure must, of necessity, be founded upon logic which is absolutely sound.

Ever since Portland cement became a factor in the contracting business it has been delivered to the ultimate consumer in packages. At first wooden barrels were used, but these were so cumbersome and difficult to handle that a small package was substituted, and now cement is handled almost universally in cloth sacks, or paper bags, four of them constituting the commercial unit—the barrel.

Cement is only one of the component parts of concrete. The fine and coarse aggregates—sand and gravel, or stone, have always been handled in bulk, and an inquiring mind uninfluenced by business custom would naturally ask "Why should cement be delivered in packages when the other aggregates are always used in bulk? Careful consideration of the subject showed many reasons why cement packages could, and should, be eliminated from a great many classes of concrete work, and to demonstrate the practicability of this new idea, the people who originated it presented it to certain contractors for their favorable consideration, which was at last secured.

The present age is one essentially of conservation, not of conservatism, and if it can be shown satisfactorily that there is an economic waste in packing cement in sacks only to reduce it to the bulk condition before it can be used, the attention of every contractor who must necessarily pay for this packing and unpacking of cement is immediately challenged. If the contractor can be relieved of this expense and at the same time can purchase his cement for a less figure, it is obvious that there will be a larger margin of profit for him in his work. Those who adopt this method first will have the advantage over their competitors.

The cement company which developed this idea offers cement in bulk for 42 cents a bushel barrel less than the price of cement in cloth sacks. Forty cents of this is, of course, represented by the cloth sacks themselves, and two cents represents the saving to the cement company in packing and loading cement in bulk. Therefore, as far as the manufacturer is concerned, the only saving in this method is in elimination of the cloth sacks which would otherwise be used. This, of course, relieves the manufacturer of the cost of counting, inspecting, cleaning, and repairing these sacks when they are returned to the mill by the contractor for credit. On the other hand, new machinery is necessary to load and weigh bulk cement when it is placed in cars. A device called a weightometer has been adapted for this purpose. This machine consists of a belt upon which the cement is conveyed into the car. This belt passes through the weightometer and all the cement on it is automatically weighed and recorded by the machine, so that the operator can tell by a glance at the dial exactly how many pounds of cement have passed through the machine into the car. A car of bulk cement, therefore, in being loaded, is weighed as a unit. When it is loaded, figuring—as is done in the United States—376 pounds to the barrel of cement, and assuming that the car is to contain 250 barrels, the belt is stopped when the dial registers 94,000 pounds, and the entire car is thus weighed in one operation. If the same car be loaded with cement in cloth sacks, 1,000 sacks would be required, and likewise the necessity of weighing 1,000 separate objects. Thus the liability of error in weighing is reduced from one thousand chances to one. It is, of course, the object of every honest manufacturer of cement to furnish correct weight, and cement in bulk represents the most satisfactory way of doing this.

Protecting Cement From Moisture

Some doubt may be raised as to the difficulty in protecting the cement from moisture, both in transit from the mill and at the mixing plant, but this has proved to be purely theoretical. The damage to bulk cement in transit by reason of a leaky car is shown by actual experiment to be 50 per cent of the damage the same amount of water would inflict if falling on cement in cloth sacks. The reason for this is that when water comes in contact with the cotton cloth, by capillary attraction it spreads to the adjacent sacks, so that a leak in a car roof will frequently ruin a whole tier of sacks from top to bottom of the car, and damage a large part of the cement contained in these sacks. If water falls on bulk cement, it is absorbed immediately where it falls and the resulting damage consists of a crust of cement depending in size on the amount of water. The damage is confined to the spot immediately under the leak, and all the damaged cement can be lifted from the car in this cake.

---

[*] Paper read at the First International Road Congress at Montreal last month.

[†] President, Marsh-Capron Manufacturing Company, Chicago.

Experience has shown that the handling of bulk cement does not raise as much dust as cement in cloth sacks. The cement sifts through the sacks with the many handlings so that the natural cohesion between the particles is broken and the dust is blown away or falls off. The method of handling it in bulk saves all this waste. The method of handling, of course, varies with the physical conditions surrounding the work.

In the early stages of the development of bulk cement shipment, the material was handled successfully and in large quantities by contractors who did not spend a single cent on special equipment. They reasoned that if they could handle and measure the sand and stone (which is 90 per cent of the concrete job) by means of wheelbarrows, they could handle and measure the 10 per cent. that it would require, with equal accuracy and facility. A great many jobs of considerable magnitude are still being carried on in this way, but naturally the possibilities of bulk cement in saving labor and increasing the output of a concreting plant may be realized more fully by means of equipment more particularly adapted to the work. When the work is adjacent to a railroad track and the size of the job warrants it, a bin may be constructed alongside the track into which the bulk cement is conveyed by means of the bucket elevator. On one side this bin is built a hopper for the coarse aggregate, and on the other side one for the fine aggregate. Both of these aggregates feed from the bottom of their respective hoppers, through spouts, into the mixer hopper. Experience has shown that a non-tilting type of concrete mixer lends itself best to a plant of this kind, as it requires less head room. These aggregates are handled from the cars into these hoppers by a clam shell operated by a standard hoisting engine or by the same bucket elevator used in elevating the cement.

Many Operations Saved

Bulk cement is moved from the car by a scraper similar to that used for unloading grain. With this the cement is scraped from the door of the car into the chute which feeds into the bottom of the elevator leg. From the bin the cement falls by gravity through a measuring box into the mixer hopper. Thus we see that the only labour connected with delivering the cement into the mixer is that required to unload the car with the device above described. Two men, in one hour, can easily unload a car containing 250 barrels of cement in bulk. By this method the contractor is saved the cost of the labor which otherwise would be necessary to perform the following activities:

1. Carry the cement, sack by sack, from the car to the storage shed, and pile in shed.
2. Carry the cement, sack by sack, from the storage shed to the mixer platform.
3. Untie each sack and empty the cement, sack by sack, into the mixer hopper.
4. Shake out the empty sacks over the mixer-hopper to relieve them of all their contents.
5. Lay the sacks aside to be bundled.
6. Bundle the empty sacks for shipment to the mill.
7. Remove the bundles of empty sacks to the storage shed to await the accumulation of a shipment.
8. Load the bundles of empty sacks into a car for shipment to the mill, prepaying the freight on them. Then ensure a long wait while the sacks go to the mill and are counted and inspected there before a credit can be issued on them and a check sent to the contractor for the value of the good sacks found in the shipment.

In every one of these eight stages the sacks are liable to damage by abuse of careless workmen, by exposure to the weather, and in many other ways. Sacks also make convenient aprons for workmen, tool bags, cushions for drivers to sit on, and it is reported that even shirts made of cement sacks are stylish among some workmen. The loss on a job of this kind in all of its many phases is estimated by contractors at from five to ten cents a barrel on the amount of cement used.

Every contractor who handles Portland cement recognizes that the empty cement sack is the most fruitful source of dispute with the manufacturer, of loss on the job, and of general inconvenience in handling cement. Everyone will recognize that the elimination of the sack on the job would be a great boon. If beside securing the advantages incidental to removing the sack entirely from the work, the contractor finds himself relieved of a large item for labor in handling these sacks, both full and empty, there is no question that he should use cement in bulk wherever feasible. Where the mixing plant is removed from the railroad track 100 ft. or more, belt conveyors have been used to take the cement from the car to the elevator connected with the overhead bin. The fine and coarse aggregates may be handled over the same belt into bins provided for them so that the gravity-feed into the mixer hopper can be applied to all of the materials going into the mixer. The number of laborers saved by this kind of an arrangement varies with the magnitude of the job and in any case the saving well repays the contractor for the installation of the necessary handling machinery and for the construction of these overhead bins. But, as it has been said, the physical conditions of each job will require an arrangement best suited for its individual need.

Cement in bulk takes up less room on the job, which is sometimes very desirable. Take, as an illustration, a large paving job which we were called in on last week. This job requires 30,000 barrels of cement, which means 120,000 sacks. At 10 cents a sack it takes $12,000 more to finance the job than if the cement were delivered in bulk. This bag money is tied up until credit is received from the manufacturer for sacks returned, and every contractor knows how long it takes to get this credit.

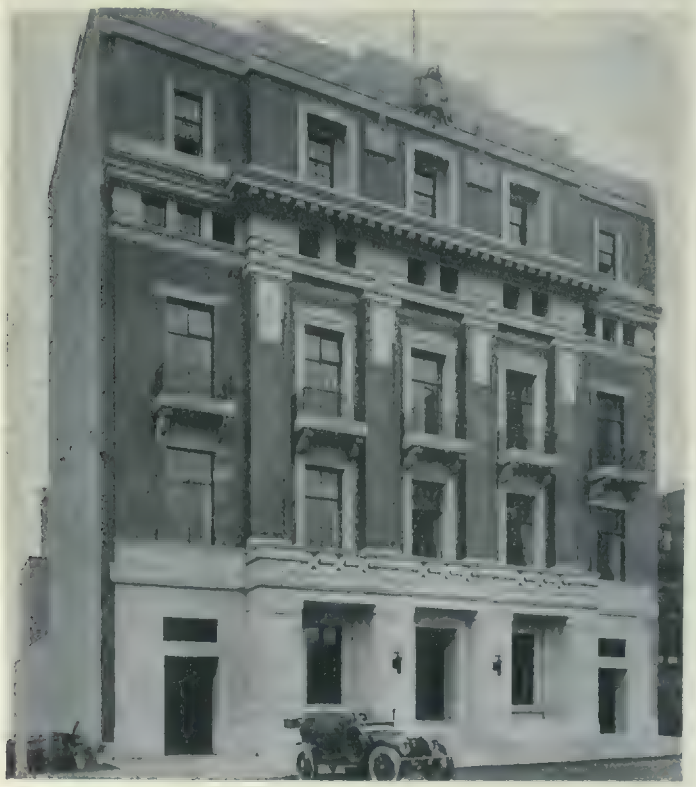
Figure the average loss of sacks and interest on money invested in this case at 10 cents a barrel, or $3,000 actual loss, to say nothing of extra labor required in handling all these sacks, and in any case the amount of capital necessary to finance the job is materially reduced. It is quite evident that this subject is worthy of study by all contractors on large work.

It is reported that construction will soon be begun of a railway bridge connecting Rugen, an island in the Baltic Sea almost due north of Berlin, with the mainland of Germany. This bridge, when completed, will be one of the longest in the world, exceeding even that over the Hwang ho, which is 10,740 feet long. The structure will probably include a track for pedestrians, although none for road traffic, and when completed it will substantially shorten the journey between Berlin and Hamburg on the one hand, and Stockholm and Christiania on the other. The cost is estimated at about $5,000,000.

The New Vancouver Club Building

THE new Vancouver Club building, illustrated herewith, has been erected in Vancouver at a cost of $290,000. The design of the building is called out in modern Renaissance. Terra cotta and light brown pressed brick have been used as the facing for the street elevation, while the side and rear walls are faced with 12-inch Dennison tile and rendered in cement. The cornice work at the front is in terra cotta. Tar and gravel have been employed for the roofing. The Hennebique design of reinforced concrete has been followed throughout for all reinforced concrete work. There are several panel beams of approximately 56-foot spans over the main dining room and billiard room, and one beam with a 60-foot span supports the two upper floors. The main entrance consists of a large vaulted vestibule which leads into a spacious lobby lounge with domed and ornamental ceilings.

The building was designed by Messrs. Sharpe & Thompson, Vancouver, who, by the way, are the architects for the proposed British Columbia University buildings. The general contractors were the Norton-Griffiths Steel Construction Company, of Vancouver.



The New Vancouver Club Building.

Some of the difficulties which confronted the English engineers when constructing some of the railways in India are referred to by a writer in the Philadelphia Record. Cliffs rising several thousand feet from the river, almost as smooth as brick walls, had to be passed. The services of the best cragsmen in the mountains were secured. The boldest of them, who would creep where a goat would scarcely venture, bored holes at intervals of 15 ft., in which they fixed strong iron bars. On these were hung ropes and planks, from which the men could begin their work, while suspended thousands of feet above the river. When the bold cragsmen came to a part of the cliff so smooth that even they could find no foothold they would scale the precipice by going back and ascending it at some point which afforded footing. Fixing an iron bar in the rock as low down from the top as they could, they would be let down by a rope until they hung at the level of the proposed road. Then, boring the rock, they would fix therein an iron bar and connect it by a rope bridge with the last point gained. The active hillmen, careless of dizzy heights, would crawl on the bridge, bore the cliff, and let in bars at the intermediate points. On these bars planks were laid, on which worked the coolies who built the viaducts.

The fire risk in floor openings to accommodate belt or rope drives has not been as fully appreciated as the safeguarding of vertical openings through floors at stairs and elevators by placing them in towers well cut off from the remainder of the building. The protection of belt openings has been handicapped by the lack of a construction suitable for use in mill buildings where the belt or rope towers were not provided for in the original design. Partitions of expanded metal and cement construction, 2-in. or more in thickness, have been found well adapted for the enclosure of such main drives in existing buildings. These cement partitions, it is said, can be installed at a cost not greatly in excess of combustible forms of construction.

"In making fire prevention work effective the public has to be considered," said Robert D. Kohn, president of the National Fire Protection Association, recently. "Men are continuing to put up buildings badly constructed, dangerous to life and to other property; putting such structures up mainly through ignorance. The difference in cost of fireproof and non-fireproof construction has been gradually cut down. To-day for structures of any importance this difference is so small that the owner would be amply recompensed for the increased cost by the lower insurance rate. In buildings where the cost of fireproof construction is still prohibitive there are simple protection devices which can be introduced to make a non-fireproof building almost as safe as one of steel and concrete."

In a paper read before the American Institute of Electrical Engineers, Mr. L. A. De Blois gives a description of investigations conducted for a large manufacturer of explosives to arrive at a suitable system of lightning protection for buildings containing explosives. The paper is divided into the following sections:—(1) An analysis by oscillograph of the secondary currents induced by actual lightning discharges in vertical earthed conductors, the results seeming to indicate that such currents are non-oscillatory and aperiodic, though occurring in either a negative or positive direction. An attempt is made to explain the phenomena generally attributed to high-waves of almost vertical front. (2) An investigation of the primary effects of a 20-in. spark in air having the same essential characteristics as those attributed to lightning when applied to a model protective system consisting of isolated vertical conductors surrounding a small building. (3) An investigation of the secondary effects produced under the above conditions, which are considered to be static inductive rather than dynamic inductive. A brief description is given of a general protective system recommended for explosives buildings.

Personal Mention

Mr. J. R. Duncan of the Vulcan Ironworks, New Westminster, B.C., is visiting several steel works in the Old Country.

Mr. C. R. Yuill, C.E., has completed plans for the construction of four reinforced concrete bridges for Armstrong, B.C., to which city he is consulting engineer.

Mr. G. R. Blair is acting-manager for Ontario of the Eugene Phillips Electrical Works, Limited, Toronto, pending the appointment of a successor to Mr. T. R. Fulton, resigned.

Mr. A. E. Foulds, of Brantford, is discontinuing his business of manufacturers' sales agent and dealer in building supplies to accept a position as estimator and purchasing agent for Messrs. R. H. Secord & Sons, Limited, general contractors, of Brantford.

Obituary

Mr. Wm. R. Perrin, President of the W. R. Perrin Company, Toronto, manufacturers of filter presses, died at Chicago recently, aged 50. He was the architect of the new municipal abattoir at Toronto, Ont.

Profesor Robert Crawford, the eminent engineer, who carried out several important schemes in Canada, died on June 9 at Ballyshannon, Ireland. At one time he filled the chair of engineering at McGill University.

Mr. Robert H. Skelton who for six years past was manager of the Ontario Sewer Pipe Company, Limited, Mimico, Ont., died suddenly from hemorrhage of the brain on June 10. Deceased was at one time G. T. R. station agent at Mimico.

Mr. Robert H. Jupp, engineer for the county of Simcoe, Ont., was instantly killed on June 5. When inspecting work on a new county bridge being constructed at Nicolston, between Alliston and Cookstown, he fell through a hole in the flooring and dropped a considerable distance to the hard ground. For several years the late Mr. Jupp has held the position of County Engineer of Simcoe, and superintended the expenditure of large sums on the roads of the county.

Mr. Wm. Armstrong, C.E., died at his residence, The Priory, Toronto, on June 9, at the advanced age of 93. The late Mr. Armstrong, who was a native of Dublin, Ireland, came to Toronto in 1851. As a civil engineer he designed and built important sections of the old narrow gauge Grand Trunk Railway. He accompanied Sir Garnet Woolslley, as chief engineer with the first Railway Expedition. He was also a well-known artist and a member of the Royal Academy. He was the son of General Sir Alexander Armstrong, who was at one time Commander-in-Chief of the British Army and who fought at Waterloo.

Miscellanea

The steamer Pueblo of the Canada Cement Company, of Montreal, is reported to have carried away six lock gates on the Welland Canal on June 10. The accident was due to the steamer being driven ahead instead of astern after entering lock 9, with the result that the foot gates were unmitred and pushed out. The rush of water tore both head gates from their fastenings, and also damaged the two head gates of lock 8. The head gates of lock 9 are fitted with the Gowan safety device, but the lower gates, with which the boat collided, are not so equipped. Repairs were carried out by a Government crew.

Arbitration proceedings have concluded before Mr. P. H. Drayton, K.C., at Toronto, to assess the damages alleged to have been sustained by the Logan brickyards, owing to the widening of Greenwood avenue by the city, north of the G. T. R. tracks. Mr. Logan claims $100,000, contending that the widening made the space on the high grounds in the yards so narrow that it was inadequate for the operation of the kilns, and for making driveways and storing fuel and brick. Counsel for the city, Mr. Geary, called Mr. L. W. McArthur, of Montreal, to give expert evidence, the latter being superintendent of three large plants. Mr. McArthur stated that there was no reason why a kiln should not be built on a slope. The award will be made by the arbitrator.

St. John, N.B., is to have a new hotel at a cost of a million dollars. The Imperial Hotel Company of St. John, Limited, was incorporated last week, with an authorized capital of one million, by C. H. Cahan, Jr., for St. John, and Montreal capitalists headed by Stanley Elkins, vice-president of the Canadian Manufacturers' Association; H. A. Powell, K.C., of the International Waterways Commission, and Rupert M. Rive. This company proposes to construct, equip and operate a first-class six storey hotel to be known as the Hotel Imperial. The plans, which have been prepared by Ross and MacDonald, architects, Montreal, who designed the Chateau Laurier, Ottawa, and the Fort Garry, Winnipeg, provide for more than 200 bedrooms, 125 of which will have private bath. The building will be fireproof and will stand on 30,000 square feet of land on the corner of King square and Sydney street, facing on King Square.

An announcement made a few days ago discloses the information that a large shipbuilding plant, with slipways, machine and construction shops, will be erected on the south shore at Vancouver, B.C., in the near future. The site of the proposed works is east of the old Moodyville mill, extending back a distance of 3,000 ft. and comprising an area of 92½ acres. The ground has been secured by the Dominion Shipbuilding, Engineering and Drydock Company, which proposes to build the works there. Preliminary arrangements have already been completed and borings for the site of the drydocks carried out. The entire plan when completed will cost practically $5,000,000. It is claimed that the new plant will be capable of building any type of vessel. A drydock with gates 100 ft. in width and 1,000 ft. long, capable of being added to later, have been provided for.

Apparently dissatisfied with the present arrangements for fire protection in Montreal the Canadian Fire Underwriters' Association have put forward the suggestion that the city should engage a body of competent engineers to prepare a report under their supervision. A deputation from the underwriters attended a recent meeting of the Board of Control and urged that an investigation of the water-works as they exist at present should be made, in consequence of the many fire losses sustained and the accident to the water conduit last December. The decision of the Board in the matter has not yet been disclosed.

The pumping plant at Toronto would appear to be in an unsatisfactory condition judging by a report submitted recently to the Toronto Board of Control by Commissioner Harris, who complained that the centrifugal pumps at the city's pumping station failed to comply with the terms of the contract as to construction, capacity and efficiency. Having endeavored without success to get the contractors to effect a remedy he now recommended that the city solicitor be instructed to proceed against the contractors and sureties for the fulfilment of the terms of the contract. The pumps were installed in November, 1909, by the Jens Orten Boving Company, who have been paid 90 per cent of the contract price. Four of the pumps are at the main pumping station on John street, and the other four at the high level station.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

Hamilton city council has approved the recommendation of the Building Inspector for the services of an assistant.

Woodstock, Ont., is to have a new City Hall at an expenditure of about $50,000. Plans have already been prepared by McBride & Gilbert, architects, London, Ont.

The Davis Shipbuilding and Repairing Company, Limited, has been incorporated at Ottawa, with a capital of $500,000, to carry on the shipbuilding business at Lauzon, Que.

The Warner, Quinlan Asphalt Company, Montreal, have a contract for paving work amounting to some $220,000. The job comprises seven and one-half miles of asphalt roads and fifteen miles of combination curb and gutter.

A six-ton motor truck of the Ontario Sewer Pipe Company, Swansea, carrying six tons of pipes, went through the Mimico Creek bridge a few days ago. The bridge is a steel frame structure, which was double-planked last fall.

The Toronto city council has decided to submit to the ratepayers during the second week in July, a by-law asking permission to expend $300,000 on motor buses. If passed an initial purchase of ten buses will be made, the number ultimately to reach a total of thirty-five.

A competition for plans for a new municipal building in Westmount, P.Q., is confined to architects or firms of architects on the Island of Montreal. The total sum to be spent on the new building is $150,000. The question of material or design is left entirely to competing architects.

The decision of the Canadian Wire & Cable Company to erect a plant at Leaside, Ont., at a cost of $1,600,000 is calculated to add greatly to the industrial importance of that district. The steel skeleton work on a large section of the building is at present under construction, and one unit of the building will be some 500 ft. in length.

Canadian architects will be invited to send in competitive plans for a public civic library to be erected at the corner of Sherbrooke and Montcalm Streets, Montreal. The building will cost $250,000. Other libraries are to be erected, and it is understood that the plans for the other libraries are to be of similar design. The prizes will be $1,000, $800 and $500 for the three best plans submitted.

At Montreal, Que., a ten-storey factory, estimated to cost about $1,000,000, is contemplated by the Henry Morgan Company, Limited. The location of the factory to be in the rear of the company's store on St. Catherine street west. The preparation of the plans is practically completed and the building will take the place of the present factory on the corner of Beaver Hall Hill and Victoria Square. It is intended to convert the present factory into offices for rental.

The contract for the construction at Toronto Island of a Ransome drifting sand filtration plant of 60,000,000 gallons daily capacity, has been given to the John ver Mehr Engineering Company, Limited, Toronto, the contract price being $1,066,282. The filtration plant is guaranteed with a cash bond of $250,000 to produce tasteless, colorless water 98 per cent bacteriologically pure and to require not more than one grain of chemical per gallon of treatment. The ver Mehr Company are prepared to commence installing the plant immediately and it is expected that it will be in operation by January, 1916. The company has guaranteed a removal of 90 per cent where there are organisms present to the extent of 50 to 500 per c.c.; 95 per cent where there are 500 to 2,000 present per c.c., and 98 per cent of all organisms where there are over 2,000 bacteria per c.c. present in the filtered water. It also guarantees a removal of 98 per cent. of B. Coli and of all turbidity, and the use of alum is not to exceed 1 grain per Imperial gallon under usual conditions.

It is stated in authoritative quarters that the United States Steel Corporation will in the near future erect in Canada a plant at a cost of $10,000,000. It is considered probable that the plant will be located at Montreal in opposition to Armstrong & Whitworth's plant now in process of erection on the south shore of the St. Lawrence. This action of the United States Steel Corporation, of which Mr. Andrew Carnegie is the head, is said to have been decided on quite recently.

Rapid progress has been made with the construction of the Cedars Rapids Manufacturing and Power Company's plant at Cedars, P.Q., by the contractors, Fraser, Brace and Company. It is expected that the Power Company will be ready to generate power by the end of this year. Concrete is being largely used in the construction of the power house. The work involves the excavation of over 1,000,000 cubic yards of earth and of about 700,000 cubic yards of rock. A large part of the machinery is being installed.

It is understood at Ottawa that the Dominion Government have decided to build the new Toronto Post Office on the site already acquired through expropriation. The post office will be on the corner of Adelaide and Victoria streets with the entrance on Adelaide street. It is proposed to erect a building on both streets 25 ft. back from the street line, and to utilize the space in front as a beauty spot. The building, which is expected to be one of the finest of its kind in Canada, will cost over a million dollars.

The building returns at Montreal show that from January 1 to May 31, 1914, the total value of building permits issued was $6,578,314, representing 1,823 buildings, as against, 1,577 buildings and a total value of $7,663,861 in the corresponding period last year. Both the number of permits issued and the value of building done during May of this year exceeds that for the corresponding month last year, the figures for 1914 being 716 permits valued at $2,517,148, compared with 655 permits and a total value of $2,473,608 in May, 1913.

The estimated cost of the new work on section 3 of the Trent Valley Canal, for which tenders have been called, is approximately $1,500,000. The section to be enlarged lies between Peterborough and Lake Simcoe, and the present contracts are all in progress. The announcement was made recently by the Minister of Railways and Canals that the entire waterway would be completed at the increased depth within four years. The lower sections between Hastings and the Bay of Quinte will be opened for traffic before the end of this year.

Plans for the Don section of the Bloor street viaduct have been inspected in private by the Toronto Board of Control. In the Don section there are five arches with 282 ft. between each. Provision is made for a 10 ft. 9 ins. walk, two 20-ft.

roads and two railways on the roadway which is 86 ft. across, over all. The railways are separated by a curb from the vehicular traffic routes. Telegraph, electric and other wires are provided for in conduits beneath the sidewalk. Tenders for the steel work will be called for at once and plans for the Rosedale section are practically completed.

WESTERN CANADA

The Marine Navigation and Engineering Company has been incorporated at Victoria, B.C., with a capital of $100,000, to carry on business at Vancouver.

The Saskatchewan Department of Public Works at Regina is advertising for tenders for the court house and land titles office to be built at Humbolt.

The Dominion government has awarded a contract to Janse Bros., for the building of a new elevator at Calgary, Alta., at a cost of $750,000. The elevator will have a capacity of 2,500,000 bushels.

It is rumored that the Roman Catholic diocese in Regina, Sask., has planned to erect 35 houses and a large church on the north side of Regina. This property is owned by the Roman Catholic church.

Messrs. James Brothers, Calgary, are the general contractors for a grain elevator to be erected in that city for the Dominion Government at a cost of $750,000. The capacity of the elevator will be 2,500,000 bushels.

Prince Rupert, B.C., is to have a new post office building at an estimated cost of $100,000. Tenders for the building close on July 6, with Mr. R. C. Desrochers, Secretary of the Department of Public Works, Ottawa.

The Saskatchewan Co-operative Elevator Company, with head office at Regina, is calling for tenders for the erection of a building at the corner of Eleventh avenue and Smith street, the estimated cost of which is $75,000.

The Provincial Public Works Department of British Columbia, has awarded to Messrs. Armstrong, Morrison & Company, Vancouver, the contract for a bridge over the Pitt River at Port Coquitlam. The estimated cost is $300,000.

Mr. F. Mollard, Secretary of the Little Manitou Rural Telephone Company with headquarters at Watrous, Sask., is calling for tenders for the supply of labor and material required for the building of the company's proposed telephone system.

Watson, Jacks & Anderson, of Nanaimo, are erecting a two-storey store and office building in that city for Mr. J. B. Nicholson at a cost of about $15,000. The building is of brick construction and was designed by Mr. A. Forrester, a local architect.

The Hon. Louis Coderre, Minister of Mines at Ottawa, has been advised that The Oil Processes, Limited, a British firm with a Canadian connection, contemplate the expenditure of more than $2,000,000 in an exhaustive search for petroleum in Northern Alberta.

The plant of the Kootenay Concrete Company, which is being launched at Rossland, B.C., has commenced operations. This plant has machines for the manufacture of building blocks, chimney blocks, pipes, ornamental work and concrete forms of various kinds.

The annual report of the Department of Mines of the Dominion Government declares that "the district between Regina and Moose Jaw, and the district along the Alberta boundary in Saskatchewan is reported to offer a chance for oil operations." It is rumored in Regina that an oil expert will investigate the matter in the near future.

A branch of the firm of Wettlauffer Bros. of Toronto, manufacturers of concrete mixers, is being opened at Regina, Sask. Temporary quarters have been secured and the company will shortly erect a building of their own. This western branch will control all the business in Saskatchewan, Alberta, and British Columbia. The local manager is Mr. A. E. Hodgert.

The Board of Highways Commissioners for Saskatchewan is calling for tenders for the construction of a number of bridges, including two reinforced concrete abutments for a bridge over the Moose Jaw river south-west of Lang, and a reinforced concrete bridge and dam north of McTaggart; also a reinforced concrete sluiceway for a dam near Langenburg.

With the intention of enforcing the city building by-laws, Building Inspector Daly, of Medicine Hat, Alta., has notified prospective builders in that city that prosecutions will follow any infringement of the local building by-laws, which require the taking out of a permit from the office of the building inspector, and the submitting of plans showing proper sanitary arrangements.

In the Calgary oil fields it is expected that derricks of the largest type will soon be employed in boring drilling rigs. A report to hand states that a California oil man, Mr. Clyde Segur, has placed an order for five separate derricks with the Wendling & Nathan Lumber Company of Oregon. These derricks are to be 106 ft. high, constructed of the straightest and toughest Oregon pine.

Mr. J. E. Asquith, town engineer of Redcliffe, is planning sewer work to be done this year to cost $200,000. A trunk sewer on Broadway, and laterals on Third and Fifth streets are all that can be done this summer. The plans prepared by Mr. W. J. Francis, of Montreal, have been received, and when finally carried out will involve an expenditure of about half a million. The trunk sewer will be built of brick, and the laterals of sewer pipe made in this vicinity.

At Winnipeg, Man., a demonstration sewage disposal plant has been in operation for the last six months. The plant is the Dickson & Centrifuge system which is stated to be admirably suited to the Canadian climate, being completely housed and economically heated during the cold weather, so that freezing up is not possible. Captain Cecil Morgan, who represents the English Syndicate running the plant, has extended an invitation to Works Commissioner Harris, of Toronto, to visit the plant at Winnipeg.

The Provincial government recently considered tenders for the construction of the substructure of the new steel bridge across the Pitt River to connect the municipality of Coquitlam with Pitt Meadows. The successful tenderers were Armstrong, Morrison & Company, of Vancouver. The total cost of the bridge will be about $500,000, and the work will be completed within twelve months. The bridge will consist of seven open dredging caisson piers and two pile-bearing piers. The approach on the west end will be 300 feet long and on the east end, 465 feet.

The city council of Calgary, Alta., has decided to re-submit several of the by-laws which were defeated by the ratepayers in April and, in addition, a new by-law making a grant of $360,000 to the Exhibition Company for the erection of new buildings, improvement of grounds, etc. The by-laws to be re-submitted are as follows:—Parks, $50,000; electric light, $300,000; concrete sub-base for street railway, $90,000; publicity and receptions, $17,000. The total expenditure asked to be authorized is $807,000 and the five by-laws will go to the people on June 26.

It was announced at Ottawa recently that the Dominion government would establish an Astronomical Observatory at Victoria, B.C., to supplement the Government Astronomical work heretofore done at Ottawa. Details of the equipment to be installed have not yet been announced but the site has been selected at Saanich Hill, north of the city proper, and it is understood that contracts for both the lenses and chemical parts have been awarded. The house is a circular building of steel construction with walls 30 ft. high and surmounted by a revolving dome 60 ft. in diameter.

A scenic road is being built from Revelstoke, B.C., up Mount Revelstoke to Victoria Park on its summit. Commencing on the western boundary of the city, at an altitude of 1,450 feet, with the aid of five switchbacks, the road reaches the summit, 12.8 miles distant, at an altitude of 6,150 feet. Upon completion of the road the Canadian Pacific Railway contemplates the establishment of an automobile service connecting its hotel at Revelstoke with the chalet at the summit, which is to be constructed by the company. The average grade of the road is 6.6 per cent and the maximum grade 7.6 per cent. The park on the summit consists of a plateau of some 70,000 acres.

A vaudeville theatre will be erected in Regina, Sask., within the next few months. The theatre, which will be known as the "Empress," will be built by Mr. William Milne of Regina, on the property immediately north of the Metropole Hotel on Rose street. It will have seating accommodation for about 1,000 persons. Plans of the building have been prepared by Messrs. Tripp & Rowley, architects, Regina, and it is expected that excavation will be commenced without delay. The building will be of steel frame and reinforced concrete, and fireproof throughout. A unique feature of the theatre will be the finish of the hallways, foyers and stairways, which will be of fancy tiled brick. The building, the cost of which will be about $65,000, will have a breadth of 50 feet and a depth of 125 feet.

Some interesting particulars bearing upon the constructional development of Dawson City, Yukon, have been received at the office of this journal. The population of the town is 2,000, it having remained stationary during the last few years. The assessment is, roughly, two million dollars and the tax rate for the present year is 18 mills. There are approximately eight miles of gravelled roads and there will be an expenditure of $14,000 on road work this season. The sewerage system consists of box sewers emptying into the river. Sewer extensions are planned at a cost of $2,000. The garbage is collected in carts and dumped into the Yukon river. Water is obtained from the Klondike river and filtered before being pumped through the mains. Water-works extensions contemplated involve an expenditure of $65,000. The installation of an electric light plant is planned by the corporation. The Superintendent of Works and Buildings for Dawson City is Mr. Isaac Lusk.

Greater Winnipeg Water Supply

IN connection with the city of Winnipeg's scheme for bringing a water supply from Shoal Lake, at a cost of $13,000,000, it is of interest to note that the most expensive part of the undertaking, the preliminaries of which are now well advanced, will be the construction of the aqueduct. The estimated cost of this is $8,729,000, the various items making up this total including the following:

Earth excavation, west of Summit cut, 1,880,000 cu. yds., at 60 cts.	$1,116,000
Earth excavation, in Summit cut, 1,100,000 cu. yds., at 75 cts.	825,000
Rock excavation, 94,000 cu. yds., at $2.50	235,000
Refill and embankment, 2,300,000 cu. yds., at 40 cts.	920,000
Concrete, 340,000 cu. yds., at $13	4,420,000
Reinforced concrete, 29,000 cu. yds., at $17	493,000
Timber platform, 13,000 ft., at $40	520,000
Steel for reinforcing aqueduct	70,000
Special work near river crossing	80,000
Gate and screen chamber and other work at intake	50,000

Surveys for the aqueduct were conducted during the winter. The frozen ground facilitated this work and it was possible to locate the line approximately on the preliminary alignment through a country almost impenetrable except in winter A section 37 miles long was run between two points 38 miles apart, with a deviation of not more than 3 miles from the air line. A uniform grade of 0.7 ft. per thousand was secured, except at two small river crossings. About 60 per cent of the country through which the location has been made is covered with small timber. Half of the distance is in muskegs. For the greater part of the length the aqueduct will be uniformly covered by a fill 4 ft. deep and it is believed that the invert will be at all points in hard ground below the swamp stratum. The administration board will have constructed typical sections of the aqueduct for testing and exhibition purposes. The board also has decided to supply all gravel, sand and cement to be used in the construction f. o. b. cars near site of the work.

The construction of the Shoal Lake water supply system is in charge of the Commissioners of the Greater Winnipeg Water District. S. H. Reynolds is chairman of the Commission, which has its main office at 901 Boyd Building, Winnipeg.

The survey parties engaged in exploration and location of the aqueduct line have been in charge of George F. Richan, Arch. Paget, Douglas I. McLean, A. C. D. Blanchard and Charles J. Bruce. Max V. Sauer is Chief of Designs in the Winnipeg office.

Canadian Railroad Development

The new Lake Shore line of the C. P. R. will probably be in readiness for passenger traffic in the course of a few weeks. This line will give practically a new route between Montreal and Toronto.

According to an announcement made a few days ago by Mr. T. C. Martin, passenger agent of the T. H. & B. Railway, arrangements have been completed for the construction of a branch line from Smithsville to Dunnville. The work will be started very soon.

Work is proceeding on the grade upon which steel will be laid to the terminal grounds of the Hudson Bay Railway, beginning at The Pas, a point south of the bridge across the Saskatchewan River. Two tracks will be laid, one to the round house and the other to connect with the C. N. R. about a mile south of the present station. The plans call for 14 tracks, with a capacity of 1,600 cars. Of these tracks 8 will be laid immediately and the balance as necessity requires.

The electrical specialties manufactured by Messrs. Gent & Company, Limited, Leicester, Eng., are described in a number of carefully-compiled, well-illustrated booklets, neatly secured under one stiff cover, received at the office of the Contract Record and Engineering Review. A particularly interesting catalogue is that of water level and sewage recording apparatus. Many important installations of this apparatus have been made by H. M. Government and by many large corporations, not only in the old country, but throughout the world. Another interesting booklet is that descriptive of the Pulsynetic system of electric impulse clocks. This system has been installed throughout the "Aquitania," Britain's largest liner. Copies of the firm's publications may be seen at the Toronto office of the Contract Record or obtained directly from Messrs. Gent & Company, at Faraday Works, Leicester Eng.

ESTABLISHED 1886

Contract Record and Engineering Review

Published Each Wednesday By
HUGH C. MacLEAN, LIMITED
HUGH C. MacLEAN, Winnipeg, President.
THOMAS S. YOUNG, General Manager.

HEAD OFFICE - - 220 King Street West, TORONTO
Telephone A. 929

MONTREAL - Telephone Main 2299 - 119 Board of Trade
WINNIPEG - Telephone Garry 856 - 302 Travellers' Bldg.
VANCOUVER - Tel. Seymour 2013 - Hutchison Block
NEW YORK - Tel. 3108 Beekman - Tribune Building
CHICAGO - Tel. Central 6403 - 1155 Peoples Gas Building
LONDON, ENG. - - - - - - - 3 Regent Street, S.W.

SUBSCRIPTION RATES
Canada and Great Britain, $2.00. U. S. and Foreign, $3.00.
Single copies 10 cents

Alphabetical Index of Advertisers
Page 16

Vol. 28 June 24, 1914 **No. 25**

Principal Contents

Important Aspects of Contract Reform 797-8
The Engineer's Estimate from the Viewpoint of the Contractor 799-800
The Engineering Activities of the City of Edmonton, Alta. 802-5
Staff Article
Advantages of Brick Paving 805
Construction of the Klondike Pipe Line 806
By W. W. Edwards
Elevated Steel Water Tower at St. Thomas, Ont. 809
Large Reinforced Concrete Pier at Halifax, N.S. ... 810-13
Hydro-Electric Development at Cedars Rapids, Que.—Progress Report 813
Water-Tight Sewer-Pipe Joints 814-15
By E. J. Fort
Color Varieties in Brick 815
Constructional Features of the C. P. R. Banff Springs Hotel 816-7
Staff Article
Reinforced Concrete in Theory and Practice 818-20
By Alexander Melville, C.E.
The Use of Marble in Architecture 820-1
The Economics of Brick Pavements 821
Specifications for Slag Foundation for Brick Pavements 821
Personal Mention 822
Featuring H. N. Ruttan and A. J. Latornell.
Building Progress at Montreal 823
Construction News and Trade Notes 824-6
General Review of Trade and Market Conditions—Montreal, Toronto, Winnipeg and Vancouver. Reports and Quotations 104

Important Aspects of Contract Reform

THERE are contractors and contractors—and how some men ever got into the business is a matter of speculation. When two men figure on the same piece of work and there is a difference of one hundred per cent in their bids it may be asserted without fear of contradiction that either one of them has mistaken his avocation or there is something wrong. It may be argued that such a difference may be occasioned by carelessness on the part of one of the bidders. To this we reply that the careless man should have no part in contracting, for his estimates can never be accepted with any reliability.

Recently we had occasion to examine the figures submitted for the construction of an exhibition building and we noticed that the low bidder was $58,000 under the next man and $145,000 under the highest bidder. Another instance is where a contractor secured the job of building a concrete sewer for rather more than $50,000, or $33,000 under the highest bidder. In a recent award of sewer work in the West the price of the low bidder amounted to $135,000, while the highest bid received was well over $200,000.

Whence such discrepancy? If it were possible to carry out the work at the low price, then the man who submitted the high bid would have made a remarkable profit, while the conditions reversed the low bidder would have incurred heavy loss. It is possible that for some unforeseen reason the high bidder did not want the contract and that the low bidder wanted the work badly and was willing to take it at a small profit, but even such speculation cannot altogether explain such disparities.

We are inclined to think that only too often the fault lies with the low man. He makes omissions, under-estimates the equipment and labor required and "cuts" his figures to a point which reduces the job to an economic absurdity. Such men are the bane of the contracting business and they should not be in it. As the "lowest" contractors they rob the good man in the business of many a legitimate prize, only to drag the trade into disrepute by reason of the scamped work they find necessary to recover part of their profit.

Contracting is essentially a business which should be conducted fairly and squarely. The incompetents and those who prostitute the business to the lowest principles of selfish gain should be eliminated. One may ask how reform can be accomplished in a day when so much depends upon dollars and cents. To this we can only reply that much can be achieved by individual effort and by united action on the part of the various constructional bodies looking to the promotion of efficiency and the setting up of a higher standard of ethics in the business. We shall always have to deal with incompetency, but as time goes on the incompetents will become fewer, as in the rush of competition it will be a case of the survival of the fittest. It is upon unscrupulousness, then, that we must concentrate, having for our watchword, "Efficiency."

It is not enough to refrain from immoral practices in contracting: one must not condone them. If we are satisfied that one of our associates in business is dishonest the only course to pursue is to cease to know him. If the few dishonest contractors were thus ostracized in the business they would find it hard to obtain credit outside of it, for there is still something of value in a good name. Reputation will always count.

If, then, we work for a higher standard of efficiency, we shall arrive at a point where incompetents will have no place in contracting. If we establish and observe a high code of ethics, and bring about certain reforms in the manner of awarding contracts, we shall place the legitimate prizes which contracting offers beyond the reach of the unscrupulous. Then, perhaps, we shall find less disparity between the high and low bids; and then, perhaps, it will be necessary to cast about for fresh editorial topics. At present, these matters, like the poor, are always with us.

Co-operation Productive of Close Bidding

THE desirability of calling for bids with a view to encouraging bidders and close bidding is a topic of editorial consideration in a recent issue of Engineering and Contracting. The article is a timely one, for such shortcomings on the part of many engineers—in Canada at any rate—have been notorious.

To our mind it is only too often a case of the right order of things reversed through unnatural developments. How often do we not find the government employee, a servant of the public, according such treatment to the public who pay him as to turn conditions topsy-turvy, making the public subservient. With the engineer the basic defect is the same. He loses balance—becomes top-heavy with an exaggerated sense of his own authority.

The impartial attitude towards contractors which the engineer has to observe does not preclude his giving that assistance which is absolutely essential in the best interests of the work. As our contemporary points out, the engineer and contractor should be co-workers, entitled to a joint knowledge of all facts bearing upon the cost of performing the work.

A call for bids has two main objects—one, to securing a structure of specified design and structural integrity, and the other, to secure this structure at lowest cost. To attain these objects close bidding must be made possible and the only way to do this is by eliminating uncertainties as to construction.

* * *

THE LOWEST RESPONSIBLE BIDDER

Not many moons ago there was a prolonged discussion in this journal of a suggestion (made originally by a writer who is now the London correspondent of the Contract Record) to award tenders not to the lowest bidder, but to the lowest bidder but one. Practically every conceivable argument was adduced, but the preponderance of opinion was in favor of leaving matters as they are. Now the matter is revived by an editorial discussion in the Chicago authority mentioned above, it having already been shown that the lowest bidder and the lowest responsible bidder on a piece of work are often different contractors.

Certainly we are entirely in accord with the finding that one of the greatest faults in the application of the contract system of doing public work is the award of contracts to lowest bidders who are not properly qualified to carry their contracts to successful completion. We quote from our contemporary, Engineering and Contracting, and commend the principles to our readers:

> This evil is becoming better recognized and there is a growing tendency to award contracts to the lowest responsible bidder rather than to the lowest bidder. Theoretically this has always been the case, but actually the vast majority of contracts for the building of public works have been awarded to the bidders submitting the lowest bids regardless of their other qualifications. This practice has been by no means limited to small towns or even to municipal works; in fact the practice has been all too general.
>
> The two quotations which follow indicate the growing disapproval among engineers of the practice here condemned. In discussing a paper on the state supervision of dams and reservoirs, presented before the New England Water Works Association, Mr. M. O. Leighton, chief hydrographer of the United States Geological Survey, said in part:
>
> > Consider the contractor. It is undoubtedly true that many dam failures have been caused by poor work on his part. You know the predicament of a contractor who is losing money on his job, and how easy it is to consider the fact that he is losing money and therefore to allow a little indulgence here and there. To secure a good piece of work under such conditions, eternal vigilance is usually necessary, and few of us measure up to eternal vigilance. One of the best ways to obviate such a difficulty is to abolish that absurd and antiquated regulation which prevails, especially in public work, that the contract shall be awarded to the lowest bidder regardless of the cost and the difficulties and regardless of the real responsibility of the man. In 90 per cent of the cases, and probably more, the expense, trouble and delay caused by a defaulting contractor who is awarded a job at a too low price, more than exceeds the difference between the successful bid and the rational one.
>
> Plans and specifications insure good construction, as a rule, only under rigid inspection. Mr. Leighton's comments bring out a point which should be more generally appreciated by those who award contracts, that is, the human element must be considered in its relation to the rigidity of inspection when a contractor is losing considerable sums of money. The responsible contractor is one who will do good work even though at considerable financial loss to himself, but this type of contractor seldom bids too low in these days of basing bids upon carefully prepared contractor's cost estimates.
>
> In his latest annual report, Mr. Charles A. Finley, superintendent of the Pittsburgh Bureau of Water, comments as follows upon the folly of awarding contracts to the lowest bidder, regardless of other considerations. To quote:
>
> > The unfortunate and unwarranted delay in some of our new work calls attention to the necessity of more rigid determination of the ability of bidders to execute the terms of contracts. These delays have arisen from lack of management. The provision in our specifications, that the bidder shall have the necessary organization, capital, experience, etc., to execute the terms of the contract, should be made to mean just what it says. The fact that a bidder is the lowest bidder should not secure for him any consideration unless he had demonstrated the ability to execute such a contract.
> >
> > A competent contracting organization is just as essential to satisfactory results as is the engineering organization which designs and supervises the work.
>
> Mr. Finley specifically names three of the most noticeable and annoying examples of delay in the completion of contracts in the recent experience of the Pittsburgh Bureau of Water. He states that in each of these cases bids were received from contracting organizations which had demonstrated their ability to comply with the progress required in the contract. They were not the low bidders, but in each case the city has lost money by awarding to the low bidders.
>
> The popular adherence to the low bid regulation undoubtedly comes, in part, from the belief that a

higher degree of honesty is present when contracts are awarded to low bidders rather than to relatively higher bidders. There are evidences that this simple faith is passing. Enough stories exploiting the smart tricks of those who graft on public works have been published in the popular press during the past few years to impress upon the more intelligent of the general public that if a disposition to graft is present the low bid regulation is easily surmounted. The public should now realize that the awarding of a contract to a high bidder for the purpose of "getting in" on the difference between his bid and the low bid is regarded as case A-sub-one among the simple forms of double-dealing under the contract system, and as much too crude a method to be employed with safety. So well is this ancient form of grafting understood that awarding a contract to anyone but the lowest bidder should be inferential evidence of the honesty of the award rather than the opposite.

The engineer-in-charge is best qualified to judge of the sufficiency of a bid and of a contractor's qualifications. If he sees reasons why the low bid should be rejected he should not hesitate to recommend that it be rejected.

The Engineer's Estimate from the Viewpoint of the Contractor

ONE of the most interesting discussions that we have read for a long time, and one which contains much sound common sense, applicable to the practice of both the engineer and the contractor, is contained in the presidential address of Mr. P. R. Fletcher before the Illinois Association of Municipal Contractors at their recent annual convention in Chicago.

Mr. Fletcher shows how unreliable and misleading the engineer's estimate often is, owing to the fluctuation of labor and material, and shows the necessity of having such figures prepared by a man of wide experience who has kept cost accounts on actual construction work. Low estimates, Mr. Fletcher points out, often result in failure to let the contract and abandonment of the proceedings. Sometimes the letting of the contract above the estimate necessitates a supplemental assessment or the award of the contract to an undesirable contractor. Mr. Fletcher continues:

Less than a decade ago estimates of cost, both by engineer and contractor, were generally mere guesses. Both, however, are beginning to realize the value of keeping construction costs, methods and costs are taken into consideration, so that a better understanding now exists as to the difficulties to be overcome in construction work.

Though every engineer and contractor has a different method of making estimates of costs, in the main and important details they are similar. For example, any one estimating the cost of concrete per cubic yard can obtain prices from the dealers on the aggregate, sand, cement, steel and lumber. The exact amount of each material needed for a cubic yard can be calculated and set down without any guessing. There are only two items—the cost of mixing and placing and the cost of erecting and removing forms, both items of labor—that remain to be estimated. By consulting some practical concrete man who does this kind of work, or taking it from cost records, the estimator can ascertain the cost of these items. Adding to its allowances for plant and general expenses, the contractor's legitimate profit and discount of paper, he has a fairly accurate estimate. This method reduces guesses to a minimum, and instead of a guess in a lump sum, what little must be done is confined to a few items, generally a small per cent of the whole. Those who follow this method and do much estimating will soon learn the various man and machine units of work per hour or per day, so that the only uncertain element of labor cost will be the fluctuation of wages.

There are many conditions which affect the fluctuations of wages. Men may be plentiful when a job starts, but wages may increase, due to the beginning of other work in the same locality or generally good business conditions, and labor become difficult to obtain. In many cities, labor unions are in control of the situation and a union scale of prices is in effect and must be met. In many smaller villages and cities, no satisfactory floating supply of labor is to be obtained. The contractor must import laborers and provide a place to sleep and feed them, an added cost on small contracts. Wages paid to local labor are always higher for an outside contractor than the prevailing local scale, usually about a 25 per cent increase.

Local laws may also affect the labor costs. City ordinances imposing regulations on maximum loads, etc., may increase the cost of the work. The engineer must look fully into the wages paid in any locality where work is to be done and also into the many conditions which might arise.

Importance of Allowing for Contingent Costs

In the case of materials to be used, there should never be any guess work as to their cost. Before the estimate is compiled, prices of all materials, based on the approximate amount needed, should be obtained in writing from the manufacturers or dealers. In the request for such prices, it should be stated what the materials are for, and about when and where they will be required.

Every contractor is familiar with the items of contingent cost encountered in nearly every specification. He reads them over and says to himself, "Oh, that isn't much; that doesn't amount to anything." It does not, if there were only one; but, taken in the aggregate and put into dollars and cents, it represents a large item of cost. If he does not figure it, his profit is reduced; and the probable reason he has never figured it out is that he could not get his bid under the engineer's estimate if he had—for the very reason that the engineer had omitted it also. Here is the big question: "Do engineers ever figure the contingent cost and add it to their estimated cost?" I believe that here is the true reason why many estimates are too low.

The following items of contingent cost enter into nearly every contract: 1. Expense of looking over the proposed work, attending the letting and closing the contract, if successful; 2. Attorney's opinion as to legality of the special assessment proceedings and bond issue; 3, Cost of the surety bond; 4, Cost of maintenance bond; 5, Cost of the liability insurance policy; 6, Moving outfit to and from the work; 7, Plant maintenance; 8, Tools lost, broken and stolen; 9, Wasted material; 10, Demurrage; 11, Losses due to weather conditions and damages of the elements; 12, Pay roll and expense of outfit in rainy weather; 13, Pay roll of superintendent and foreman for three months of the year, when not at work; 14, Local charges for use of water; 15, Broken drain or water pipes; 16, Unforeseen damages to walks and private property; 17, Cost of inspection of materials; 18, Stakes and help for the engineer; 19, Barriers and red lights; 20, Lost, torn or damaged cement bags; 21, Being a good fellow.

I could explain each of these items more fully, but the mere mention of them will suggest many instances to every contractor. Every one of these items enters into the cost of an improvement. Each is as much an item of cost as labor and material. Taken separately, they amount to but a small sum, but in the aggregate they total from 10 to 15 per cent. of the cost of an improvement. How many engineers take cognizance of these items and include them in their estimate? Yet their specifications and contracts call for them.

No business can succeed without profits, and no contracting company can succeed, and stay in business, without them. This leads to the question, "What constitutes a fair net return on municipal work?

The contractor's profit depends on the price he bids for the contract, and often varies for the same class of work. In early spring he may bid very low, to get his organization ready for the season, especially if he carried no work over from the preceding year. Later on he, perhaps, obtains contracts at legitimate prices, thus averaging up on the year's business.

On force account work, with every facility at hand to do work, the usual allowance for use of tools and profit is 15 per cent. Gillette figures profit on the basis of 10 per cent. on the cost of material and 33½ per cent. on the cost of labor. This would probably average about 20 per cent. on the whole contract.

Contractors for municipal work are paid in cash or bonds. The occasions when they are paid in actual currency are so rare that they need not be discussed. These bonds are of two kinds: the municipal bond, guaranteed by the city or village as a whole; and the special assessment bond, issued by the city or village in anticipation of the collection of the tax upon each lot or parcel of land benefited by the proposed improvement. Here are two classes of bonds issued by the same city or village for the payment of the same class of work, each drawing 5 per cent. interest, each taken by the contractor at par, yet of very different market value.

The special assessment law of the state of Illinois is considered very much superior to the similar laws in Iowa, Wisconsin and Indiana, irrespective of the fact that where only 5 per cent. interest is paid in Illinois, 6 per cent. is paid in these other states. The special assessment bonds of these states readily sell for par, owing to the increased rate of return on the investment, and the public buys them for the reason of that particular attraction. The Illinois bonds assessed on relatively the same kinds of property are sold at a discount of from 5 to 10 cents on the dollar, in order to net an average of 6 per cent. or more for the time that they have to run.

Here, then, we see the property-holders paying nominally 5 per cent. on an inflated cost of an improvement according to the state law, but paying 6 per cent. or more on the actual cost. This difference of cost of the work, ordinarily termed discount, must be added to the engineer's estimate as a part of the cost of an improvement. This discount is not always 5 per cent., but varies as the money market changes. When money is plentiful, bonds can be marketed at 95, but during the last year many have sold for less, if they could be sold at all.

Special assessments are levied against every lot or parcel of land benefited by the improvement, according to such benefits, and the assessment must be equitable. The amounts so assessed are spread irrespective of the value of the lot or the owner thereof. If the property assessed is improved, the value is greater and the security behind the bond is increased. If the property is vacant and poor in value, it has a tendency to decrease the security of the bond, unless it is so located that its improvement or the growth of adjoining property enhances its value.

Again, many assessments are spread against property which has been sold for taxes and been forfeited to the state. In this case, the state pays no special assessments. Hence, in looking over proposed improvements, before the letting, the contractor usually examines the assessment and if he finds property forfeited to the state it reduces the amount available for the construction of the improvement by the total amount of the forfeitures. If the estimate, after taking off the forfeitures, is too low to do the work, the contractor either must not bid at all or else must bid above the estimate. From these facts it follows that it should be the duty of the engineer to look over property before making his estimate, to ascertain its condition, and make his estimates accordingly.

The Value of Bonds

The first duty of the contractor, when he receives bonds for work, is to see that they are good. He must depend upon the expert attorney to advise him. But such advice, however favorable, will not force a property holder to pay his tax for an improvement, nor will it force the state to pay a tax upon a lot which has been forfeited to the state for non-payment of taxes. No special assessment bond becomes forfeited if every lot or parcel of land pays its tax. If property that is assessed for special assessment improvements is clear as to title and is worth as much or more than the assessment, there is not much doubt of the assessment being paid. It is this doubt or possible chance of a forfeiture that bankers and bond-buyers shy away from. They use it as a club to force the contractor to sell his bonds at their price. After having the opinion of the expert and of their own legal talent as well, they send representatives to look over the property assessed, and if there is no possible chance of a loss, the contractor may be offered 95 per cent., if 30 per cent. of the property is vacant, 92 per cent. If there is a forfeited lot, he will get no offer at all.

I am going to suggest two remedies that I am positive, if made law, would have a good effect on the market value of these bonds. As they depend upon the engineer's estimate they may properly be included here.

First, the engineer's estimate should be ample; enough so that after paying the contract and the 6 per cent. allowed by law for the expenses of making the assessment, court costs, etc., there would be left a residue. Our present law requires that after the cost of an improvement is determined, the residue shall be rebated to the property holders before they pay their assessments. They pay only what is actually required.

My suggestion is that no rebate shall be made until the final bond is paid. I contend that if the property owner elects to take five or ten years to pay his debt, he should pay all expenses connected with it. I contend that the contractor should not assume the collection nor stand the responsibility of the non-collection of special assessments. If there were a residue or reserve left in the special assessment fund, over and above the obligation or requirements of that assessment, it would undoubtedly go far as a guarantee toward insuring the full payment of every bond and the interest thereon, in case of a possible default in the payment of some installment.

Secondly, 6 per cent. is allowed by law to reimburse general fund accounts for cash advanced on account of the expenses of levying all assessments, and this 6 per cent. is always drawn from the first installment. Thereafter there is no fund to pay any expenses which may develop on account of the special assessment. If some of the property holders pay their assessment in full, the interest stops on their portion but the bonds continue to run until called. Here is a loss of interest and no fund to pay it. There might be a default on some payment of an assessment and no fund to pay it. The bonds are obligations of all the property holders, and inasmuch as the state has seen fit to assess them 6 per cent. for the making of an assessment, I can see no valid reason why another assessment of, say, 5 per cent., should not be levied and held as a sinking fund or reserve to pay the loss of interest and forfeiture, if any, and at the final payment of the last bond to be rebated to the property holders.

The assessing and creation of this reserve will, in my opinion, bring the value of special assessment bonds to a higher plane as marketable and investment securities. Contractors who, in bidding heretofore have figured a return of 90 to 95 cents on the dollar, would, if these provisions were a law, be able to figure on the basis of nearly par. If the creation of this reserve acts as I think it will, I cannot see that the property holder eventually pays any more than he does at the present time. What he now pays for as discount will be offset by the increased value of the bond.

The present state law requires that interest shall be paid upon all of an assessment except improvements put in upon the one-year plan. There are a great many such improvements, so small in total amount as to dollars and cents that it is impossible to make them in five or ten installments, where each installment must be a multiple of $100. Very often these improvements are put in in the early part of the season or late in the fall, and in either case the contractor must wait a year or year and a half for his money without interest. I believe the laws should be amended so that this kind of paper would bear interest, putting it in the marketable class of securities.

There seems to be a dark cloud in our special assessment law in regard to interest on the first installment where there are deferred installments. The ordinance usually sets forth that all installments except the first shall draw interest at the rate of 5 per cent., yet all municipalities collect the interest on the first as well as on successive installments.

Some municipalities issue vouchers on the first installment which bear no interest, but more of them issue those bearing interest. The former apparently have the law with them; the latter do it because they think it fair and honest, believing that as long as they collect the interest on the installment they should in turn pay it out on the voucher or bond. The special assessment law should be so amended that all installments shall bear interest and that all vouchers issued against the first or succeeding installments shall draw interest.

Summing up, an engineer's estimate, to be fair-conservative and reasonable, must be based on the following:

1. The actual cost of material and labor.
2. Contingent costs, amounting to from 10 to 15 per cent. of the above.
3. Contractor's profit, amounting to from 10 to 30 per cent. of the first two items. This will vary according to whether the contract is hazardous and difficult, requiring a large amount of special equipment, or whether it is comparatively easy, requiring but little equipment.
4. Allowance for converting the bonds into cash, amounting to at least 10 per cent. of the total amount of the contract.

Immediately after the close of the Sixth National Conference on City Planning held at Toronto last month, the Executive Committee decided that active and systematic investigations along the following lines should be pushed during the year, in preparation for the next conference: (1) To obtain reliable and comparable data for determining the effective size and distribution of playgrounds and the kindred recreation facilities; (2) To secure the drafting of a comprehensive outline of the powers, duties and administrative procedure in matters of town planning best calculated to serve the interests of the community, with a broad regard for the personal and property interests of the individuals; (3) To assemble data and define principles in regard to the design of subdivisions with a view to the most effective utilization of private property. These lines of work will be pursued under small committees who will endeavor to secure the opinion of every member of the Conference who will co-operate. The chairman of the Executive Committee is Mr. Frederick L. Olmsted, Brookline, Mass. The secretary of the Conference is Mr. Flavel Shurtleff, Boston, Mass.

An ambitious scheme for giving terminal facilities in Montreal is planned, and a public appeal has been made for British capital by the Montreal Central Terminal Company. The object of the plan is to give additional means of access to the south shore from Montreal, and to supply facilities for the exchange of traffic between the railways. It is proposed to construct railway lines, bridges, and tunnels and freight and passenger stations, involving the building of fifty miles of line. The work is to be carried out in sections, the first to provide facilities for the railways coming into the city from the north and west, while at the same time it is intended to proceed with the tunnel under the River St. Lawrence and the connections with the railways from the south and east.

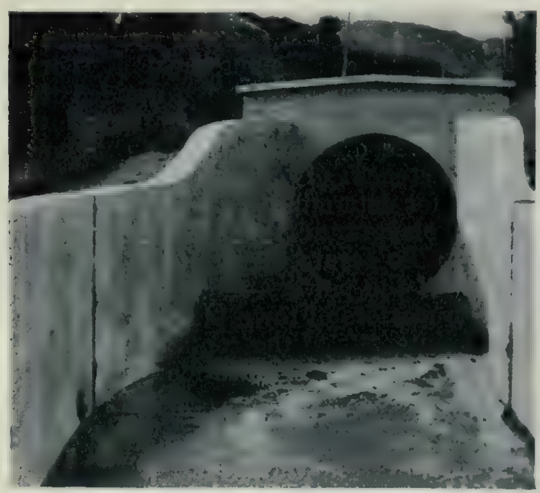
Wooden forms for concrete were used fifteen or twenty times by the E. E. Smith Company, contractor for two sections of the four-track subway in Brooklyn. They were easily removable in panels, and in cold weather were washed with hot water immediately before placing the concrete. All of the cross bracing was set so as to serve for bracing the forms as well as the outside sheeting, and the upper transverse braces were cambered parallel with the cross-section of the roadway.

The Engineering Activities of the City of Edmonton, Alta.

(Staff Article)

MUNICIPAL engineering development at Edmonton has continued apace during the last few years. This is in general keeping with the spectacular growth of the city, which only received its charter ten years ago and whose population has increased from 21,000 in 1909 to upwards of 70,000 to-day. In 1890 the city of Edmonton was nothing but a small trading post and in 1900 the population was only 2,500.

As an instance of the important place that Edmonton is taking among the constructional centres of the Dominion, it may be of interest to mention the fact that the estimate of building work to be carried out this year is ten million dollars—rather more than four times the actual value of the building work done in 1909.



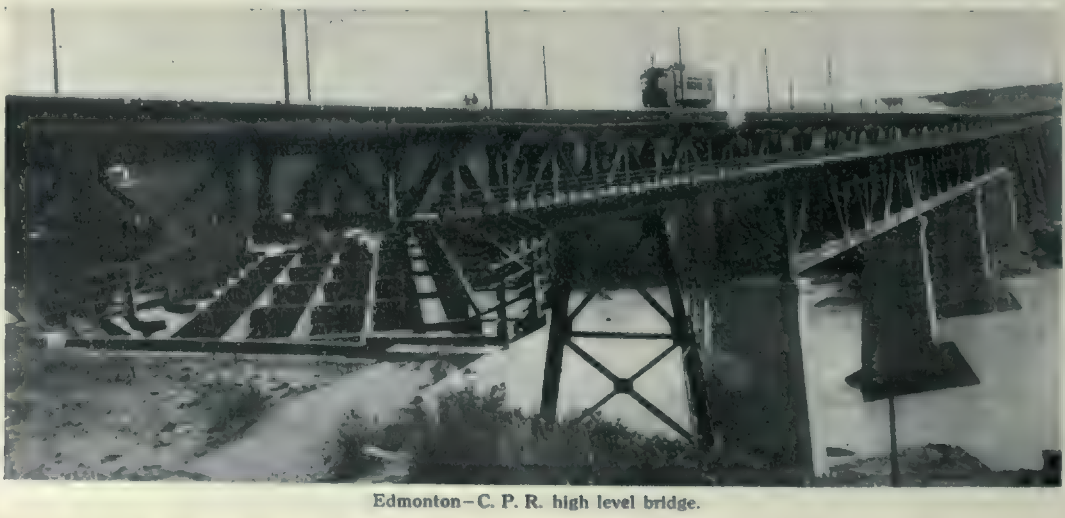
Edmonton—Outlet 10′ 6″ sewer, showing overflow.

A condensed statement of Edmonton's engineering activities was published in our issue of May 27 last, in Part III of "Canadian Constructional Centres." In the present article, thanks to the co-operation of the City Engineer, Mr. A. J. Latornell, mention of whom is made in the personal column of this issue, we are enabled to give some further interesting details concerning the work and administration of the Engineering Department.

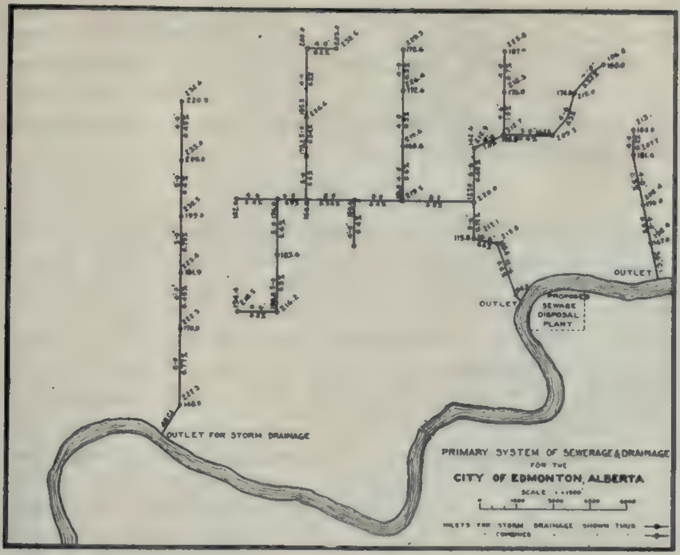
SEWERAGE AND DRAINAGE

There are one hundred and twenty miles of sewers in the city, varying from 8-in. to 10-ft. 6-in. The extensions planned for the present year comprise a total of approximately forty miles, at an estimated cost of $2,000,000. The materials used in sewer construction are vitrified tile pipe up to and including 24-inch and above this size, brick, plain and reinforced concrete, with vitrified segment blocks.

The trunk system now under construction is being built entirely in tunnel, varying in depth from 40 ft. to 100 ft. below the ground surface. The plateau on which the greater part of the city of Edmonton is built is situated 160 to 200 feet above the waters of the Saskatchewan River, into which the tunnel system discharges through the 10 ft. 6 in. sewer. The form of sewer used in this tunnel was designed by Mr. Alexander Potter, consulting engineer, New York City, whose article, "Sewerage and Drainage Improvements at Edmonton," was an interesting contribution to the April 30, 1913, issue of this journal. The sewer is constructed of concrete blocks, manufactured on the surface, the mix used being 1:2:3. Around the outside of these blocks when built into the sewer is placed a steel band. This band is in two pieces, the ends being drawn together by means of coupling shoes, which permit the band to be drawn up tight around the blocks. One of these bands is used for each ring of blocks, thus giving a band spacing of one foot centre to centre. Around the outside of these blocks and bands is placed about 4-in. of concrete, which serves to cover and protect the bands, as well as to fill the spacing between the outside of the blocks and the earth walls. The lower half of this envelope of concrete is placed prior to



Edmonton—C. P. R. high level bridge.


OUTLET
OUTLET
PROPOSED SEWAGE DISPOSAL PLANT
OUTLET FOR STORM DRAINAGE
PRIMARY SYSTEM OF SEWERAGE & DRAINAGE FOR THE CITY OF EDMONTON, ALBERTA
INLETS FOR STORM DRAINAGE SHOWN THUS
COMBINED

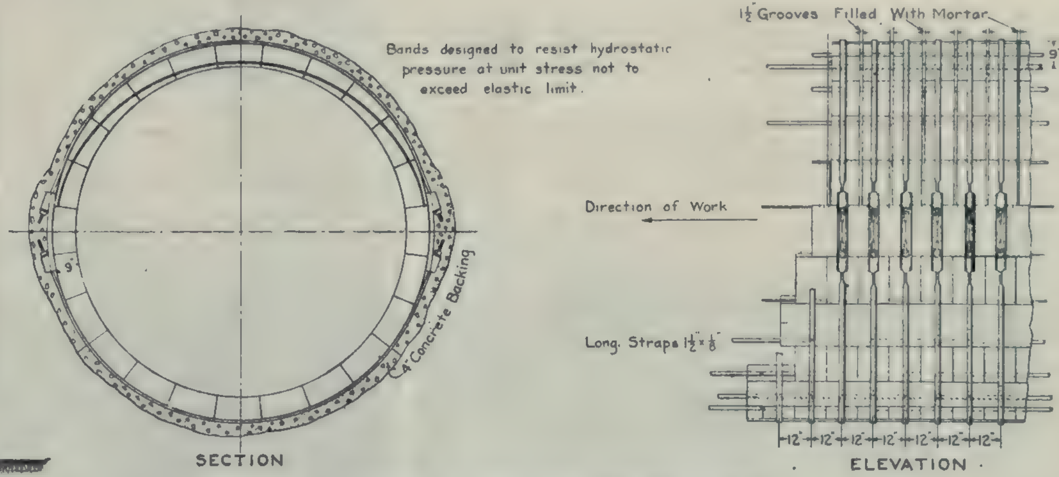
the blocks, whereas the top half is deposited after the blocks have been placed.

Steel reinforcement is also used in the joints between the blocks. The hooping bands are designed to resist an internal or bursting pressure equal to the depth of the sewer below the surface without stressing the steel beyond the elastic limit. Already about eight miles of this type of sewer have been constructed and the results have fully justified the design.

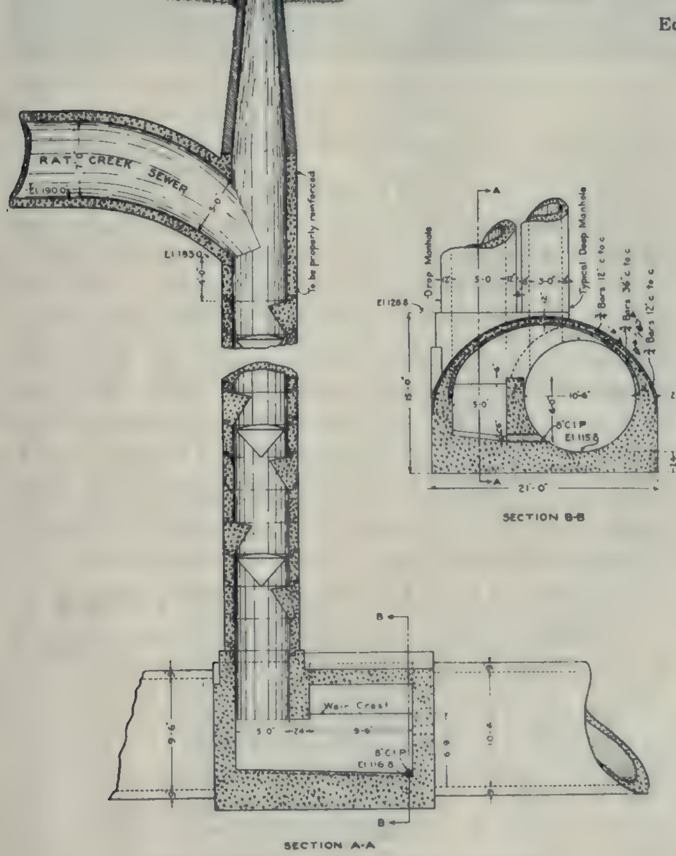
The material through which the tunnel has been driven is for the most part a gray clay, blasting being necessary for its removal. The finished sewer follows up as fast as the excavation is done, so that in the class of material encountered practically no timbering is required. An electric hoist for hoisting material to the surface and lowering material for the construction of the sewer is used throughout the work.

The sewerage system is a combined system as far west as Twenty-First Street. West of this, the separate system is used, the sanitary sewage being carried eastward by sanitary trunks and dropped into the tunnel trunks described above. Although collected in purely sanitary sewers, it is discharged into the tunnel trunks and mixed with the combined sewage and storm water of the main system. The reason for this is to avoid carrying the storm water of the western district such a long distance eastward with the resulting large increase in the size of the tunnel trunks.

Details of Sewerage and Drainage Improvements at Edmonton, Alta.


Bands designed to resist hydrostatic pressure at unit stress not to exceed elastic limit.
9"
4" Concrete Backing
SECTION
1½" Grooves Filled With Mortar
9"
Direction of Work
Long. Straps 1½" × ⅛"
12" 12" 12" 12" 12" 12" 12"
ELEVATION

Edmonton—Typical sewer construction in tunnel.



Edmonton—Typical drop manhole construction.

As the waterworks intake is east of Twenty-First Street, the usual method of separating the storm water from the combined system by providing an over-flow could not be used—hence the storm water west of this street required to be collected in a separate system of pipes.

The water and sewer pipes over a greater part of the territory are laid in the lanes. These lanes are 20 feet wide, and the sub-division provide fairly complete system of lanes, so that it is possible to make use of these for the installation of practically all the utilities. This leaves many of the streets with no underground work. This should materially increase the permanency of the surface work.

SEWAGE DISPOSAL

Very little other than the preliminary work leading towards sewage disposal has as yet been done. This preliminary work consists of concentrating the sewage at as few outlets as possible and acquiring the land necessary for disposal works at the point of outfall.

Distribution of Local Improvements at Edmonton, 1900—1913

Year	PAVING Constructed Sq. Yds.	PAVING Constructed Miles	PAVING Existing Sq. Yds.	PAVING Existing Miles	CONCRETE WALK Constructed Sq. Yds.	CONCRETE WALK Constructed Miles	CONCRETE WALK Existing Sq. Yds.	CONCRETE WALK Existing Miles	PLANK WALK Const'd Miles	PLANK WALK Exist'g Miles	GRADING Const'd Miles	BOULEVARDS Const'd Miles	BOULEVARDS Exist'g Miles	SEWER Const'd Miles	SEWER Exist'g Miles	WATER Const'd Miles	WATER Const'd Miies	TELEPHONE Exist'g Miles
1900 . .	....	......	....	......	....	......	....	... ..	.....	.....	No Record	.....	......	.....	......	.....	......	.....
1901 . .	....	......	....	......	....	......	....	... ..	1.0	.....	No Record	.....	......	.....	......	.....	......	.....
1902 . .	....	......	....	......	....	......	....	... ..	2.4	.....	Expended $457.35	.....	......	.....	......	.....	......	.....
1903 . .	....	......	....	......	....	......	....	... ..	6.5	.....	Expended $222.14	.....	......	.....	......	.....	......	.....
1904 . .	....	......	....	......	227.00	.04	227.00	.04	6.92	.....	.50	.....	......	.....	......	.....	......	.....
1905 . .	....	......	....	......	10,105.00	1.50	10,332.00	1.54	7.75	.....	3.80	.....	......	.....	......	.....	......	.....
1906 . .	....	......	....	......	15,840.00	2.38	26,172.00	3. 2	8.00	33.0	6.09	2.750	2.750	2.70	10.90	4.00	13.88	.....
1907 . .	40,967.70	1.210	40,967.70	1.210	10,584.00	1.68	36,756.00	5.60	9.30	36.0	1.60	.580	3.330	11.37	13.60	.14.42	32.30	1.58
1908 . .	63,048.30	1.700	104,016.00	2.910	6,373.17	1.05	43,129.17	6. 45	9.03	44.1	1.10	.845	4.175	9.13	24.97	7.54	39.84	.35
1909 . .	45,969.40	1.179	149,985.40	4.089	1,390.40	.323	44,519.57	6. 73	9.90	54.5	18.50	3.668	7.848	7.77	34.10	10.45	50.29	.50
1910 . .	38,449.90	1.038	188,435.30	5.127	327.00	.09	44,846.57	7. 63	5.90	60.0	7.53	1.752	9.595	3.94	41.87	4.72	55.01	1.50
														Scona	17.83			
1911 . .	67,304.12	2.488	255,739.42	7.615	30,564.00	6.32	75,410.57	13. 83	30.80	90.0	46.07	5.252	14.847	4.93	45.81	5.69	60.70	.50
1912 . .	249,231.50	11.770	504,970.92	19.385	49,427.20	10.998	124,837.77	24. 81	15.67	101.0	4.00	5.758	20.605	13.39	81.96	36.00	96.70	4.80
1913 . .	441,497.55	22.231	943,700.67	41.556	44,837.10	11.037	168,710.87	35.270	16.93	113.0	10.63	9.132	29.177	30.34	112.30	31.90	128.60	10.00
Totals ..	946,468.47	41.616	943,700.67	41.556	169,674.87	35.418	168,710.87	35.270	130.10	113.0	99.82	29.740	29.177	83.57	112.30	114.72	128.60	19.23

One of the present outlets discharges into a septic tank constructed some years ago, but the balance of the plant has not yet been completed. It is proposed to instal a plant at one of the smaller outlets this year. This will consist of Imhoff tanks and, for the present, sterilization of the effluent.

ROADWAYS

The table submitted gives the comparative growth of street improvements in the last nine or ten years. It will be noted that in 1913 these were: paving, 22.231 miles; concrete walks, 11.037 miles; plank walks, 16.93 miles; grading, 10.63 miles; boulevarding, 9.132 miles. The work contemplated for the present season will amount to an expenditure of from one and one-half million to two million dollars.

In designing a street improvement one of the first questions to be decided, and one which is very difficult to settle, is that of the cross-section of the street. The total width of the street is usually settled by the subdividing. The problem of the proper cross-section of the street involves a forecast of the probable use of such street, and the varying uses to which it will be devoted, and that portion of the street that should be set aside for each class of traffic. Owing to the constantly changing conditions and the various stages that a street often undergoes, passing from residential to retail business, the engineer in deciding a cross-section should plan so that a street may be converted readily from one cross-section to another at some future time with minimum alterations.

For example, taking a wholesale section, the gutter is placed at the same distance from the property line as the curb line of a retail street; then by removing the curb and paving up to the property line, the retail street is converted into a wholesale street, the walks being placed in the centre. In the same way a wholesale street could be converted into a retail street. On a boulevarded street, the outer edge of the concrete sidewalks is placed just 6 ins. back of the curb line on a business street of the same width. Should it be desirable to convert this boulevarded street into a business street, this 6 ins. is taken up by the curb of the pavement.

WATERWORKS

The water supply is taken from the North Saskatchewan River, the water being pumped by low lift centrifugal pumps to the sedimentation basin and thence through gravity mechanical filters to the Filter Water Reservoir. After being treated with hypochlorite of lime, the water is pumped by the service pumps into the distribution system. The distribution system consists of 128.6 miles of pipe, varying in size from 4 ins. to 20 ins. The pressure of the distribution system is maintained directly from the pumps. These are capable of giving the necessary increased pressure required for fire purposes—although the Fire Department is equipped with motor-driven fire pumps.

STREET RAILWAY TRACK CONSTRUCTION

The street railway system, like all the other utilities, is municipally-owned. During the year 1913 a large programme of permanent track construction was carried out. The design of the permanent track construction was completely changed from that previously used. Instead of the girder type of construction, that is a construction using a concrete beam running under the rail as its support, a 6-in. concrete slab was laid across the street railway allowance. The skeleton track was then laid upon this, wooden ties being used underneath the rails. The rails and ties were then concreted in with a concrete filler and pavement surface laid on top.

Owing to the almost prohibitive cost of granite sets or other similar material, a paving between the gauge line of the rails was made of 4-in. reinforced concrete slab. It is expected that this will give fair service, owing to the generous width of the streets of this city, which does not necessitate the same use of the car track space as if these streets were narrower.

C. P. R. ENTRANCE

Practically all the structures required to separate the grades of the C. P. R. entrance from the city street grades have been completed. This work involved the construction of subways at Saskatchewan Avenue and Jasper Avenue, with overhead bridges at McKay Avenue and Victoria Avenue.

At Saskatchewan Avenue the steam tracks are carried on a high fill, making the construction of a grade separation at this point very simple and with comparatively little damage to the abutting property. In this case abutments were placed at each property line upon which was placed a through plate girder structure carrying the steam rails over the roadway. The approaching grade from the west is 4.5 per cent, while the approaching grade from the east is practically level.

Edmonton - Jasper Avenue Subway.

Edmonton—Saskatchewan Avenue Subway.

On McKay Avenue the grade separation is made by a bridge over the tracks. At this point the steam tracks are in a cut of 12 feet, which brings the top of the bridge 13 feet above the general ground elevation. The bridge structure itself is made up of reinforced concrete having approaching grades of 4.75 per cent from the west and 5.5 per cent from the east. Provision has been made for a double line of car tracks in the centre of the 40-foot roadway, with two 5-foot concrete walks, one on each side.

On Victoria Avenue the grade separation is made by a reinforced concrete bridge similar to that on McKay Avenue. The approaching grades in this case are somewhat steeper than they are on the other bridge, being 6.5 per cent on the west approach and 8 per cent on the east approach. The roadway is made 30 feet wide with 5-foot sidewalks on each side.

On Jasper Avenue the steam railway crossing is at an elevation of 4 feet above the original elevation of the street. This made it necessary to depress the roadway into a cut of 13 feet. In approaching the crossing from the east, the descent is on a 5.5 per cent grade, while the approach from the west is much lighter, it being only 1.6 per cent.

The construction of the subway itself was carried out by the C. P. R., but the construction of the street railway tracks and the paving base was carried out by the City Construction Department.

In laying down the general policy for the subway construction it was decided to eliminate as much of the retaining wall construction as possible, in order that business buildings might be built almost up to the subway structure itself. If this object can be accomplished it will practically eliminate the appearance of a subway, especially when the subway zone has been built up with business houses.

Advantages of Brick Paving

THE adaptability of brick to rural highway construction was the subject of an elaborate exhibit at the recent International Roads Congress held in Montreal. Many Dominion cities are large users of brick for urban pavement, but the country road of brick is a comparative novelty in Canada. However, its rapid rise to favor in parts of the United States has attracted attention and visits from many Canadian highway engineers. The vicinity of Buffalo and Cuyahoga County, Ohio, which contains Cleveland, are the leading brick road localities of the world.

The success of the brick road has been largely due to its permanence under the new conditions of power traffic which have played havoc with older types of road improvements. The hardness of brick enables it to withstand the friction and tear of the rapidly running automobile. This quality so appealed to Governor Glynn, of New York state, that he recently devoted an entire message to the legislature on the advocacy of brick for all main highways in the state of New York. Cuyahoga County, Ohio, has nearly 400 miles of this type of rural road, built at an approximate cost of $1,000 per mile for each foot in width. One effect of these roads has been such a rapid rise in rural land values in the county that their increased tax valuation has more than covered the cost of construction.

Such roads have won their way to the appreciation of auto owners and farmers alike, being equally passable in any season of the year and so drained that every rain washes them clean. Where other types of road require constant vigilance and constant expense for maintenance, a properly constructed brick pavement, according to government authorities in the States, has never yet been known to wear out.

In the progress article descriptive of the Methodist Book and Publishing House, Toronto, which appeared in the Contract Record of June 10, we inadvertently omitted to state that the steel frame construction was designed by Messrs. Harkness & Oxley, Consulting Engineers, Toronto.

Construction of the Klondike Pipe Line

Engineering Difficulties Arising Out of Severe Climatic and Other Conditions and the Methods by Which They Were Overcome

By W. W. Edwards

THE Klondike pipe line was built during 1907 and 1908 by the Yukon Gold Company, at Dawson, Yukon Territory. It is an inverted siphon crossing the Klondike River Valley, and was designed for a capacity of 125 sec.-ft., which figure, however, has been slightly exceeded in operation. The maximum head on the pipe line is about 1,100 ft. The total length of 15,760 ft. is made up of: 2,390 ft. of wood stave pipe, 49-ins. inside diameter; 5,850 ft. of rivetted steel pipe, 49-ins. inside diameter; and 7,520 ft. of lap-welded steel pipe, 43-ins. inside diameter. The steel pipe ranged in thickness from 3/16 to 11/16-in., and came in lengths of from 15 to 30 ft. It is the largest of several inverted siphons along the line of the Main Ditch System of the Yukon Gold Company, 70 miles in length, which supplies water for hydraulic mining operations on Bonanza Creek, near Dawson.

The location of the pipe line was determined chiefly by two conditions: It was necessary to cross the valley below the junction of Bear Creek, and also to keep above the dredging ground of the Canadian Klondike Mining Company. These two determining features left little room for adjusting the line to fit the ground conditions, but it is probable that the location adopted was as good as could be obtained in any case.

The intake end of the pipe is on a comparatively steep side hill. This hill is of decomposed schist covered by a foot or two of soil which supports a growth of bushes, poplars and a few spruce trees. The flat valley of the Klondike is here about 5,000 ft. wide. It is covered with a blanket of Arctic moss from 1 to 2 ft. in depth. Below this there is a layer of frozen "muck," or vegetable mould, which is generally about 5 ft. thick, and below this is generally found gravel. This formation is peculiar to the North, and will warrant a little explanation. The frozen "muck," or "frost," as it is sometimes called, is made up of decomposed roots, moss, tree branches, etc., mixed with some little rock and sand, and the whole mass is frozen solid. The moss blanket on the surface protects it from the summer heat, and whenever this blanket is undisturbed the ground beneath the moss remains frozen the year round. If the moss covering is removed, however, allowing air and water to act on the frozen muck, it soon melts. This condition may be found in almost every river valley in the far north, as well as on the sheltered hill slopes. In places the "frost" has been built up by the seasonal thaw not penetrating fully through the winter's freezing, and extends to a known depth of 200 ft. and unknown further depths. This condition makes the question of foundations quite serious. The "frost" is a good foundation if it is not disturbed, but, if disturbed, the structure placed in it must be frozen in and the surface mossed over again to keep out the air and water absolutely. If this cannot be done, the structure must be carried through the frozen muck to good gravel or bed-rock foundation. Frozen muck was encountered all the way across the Klondike Valley and in spots along the pipe up the sidehill as far as the discharge box.

Only two horizontal angles were made in the pipe line, with the exception of those used in making a short offset around the base of a hill. Manholes, drains, and air-cocks were provided wherever necessary. Cast steel expansion joints were put in every 500 ft. to allow for the expansion and contraction due to the extreme variation in temperature, from 80 deg. F. in summer to —70 deg. F. in winter. One three-span steel bridge, 295 ft. long, was necessary in crossing the Klondike River, and a total of several hundred feet of pile trestle or framed trestle were put in at various places along the line. The aim was to have the pipe supported at least once in every 16 ft. Whenever the conditions warranted it, as for instance, when good foundation was deep, trestle bents were built every 32 ft. and kingpost trusses were put in to give the intermediate bearing. In good material, sills were merely laid in the bottom of the pipe trench and on these the pipe was supported. Whenever the foundation was within 3 or 4 ft. of the pipe, crib supports were used; if greater than 4 ft., framed bents were used.

One anchor was put in at least every 500 ft., about midway between expansion joints, and, when necessary, they were used more frequently. Each anchor consisted of a cable wrapped around the pipe in the form of a clove hitch, the ends being made fast to two "deadmen" on opposite sides of the pipe. Each "deadman" was set in the ground about 6 ft. below the surface.

On the side-hills drains were dug at frequent intervals to lead off seepage and leakage. At every drain a bulkhead was put in which fitted closely to the pipe and effectually intercepted the water.

In many ways conditions were unique for heavy construction. Common labor was paid $4 per day and board. The working season was short, being limited to five months—May 1 to October 1. Some kinds of equipment were plentiful in the country, notably steam engines and boilers, but in other lines it was sadly lacking. A well selected stock of equipment was ordered for the job, but breakages and unforeseen difficulties sometimes caused awkward situations, in view of the distance from a base of supplies.

Power was furnished from the Yukon Gold Company's hydro-electric plant on Little Twelve Mile River, about 50 miles from the pipe line. It was delivered at the main transformer house at 33,000 volts, and there stepped down to 2,300 volts. From there it was distributed at this voltage to the transformer banks at the several compressors and at the machine shop, where it was stepped down to 220 volts.

Construction was begun in 1907. The right of way was cleared and a small quantity of pipe trench was dug. The three-span steel bridge over the Klondike was erected. Foundation cribs were put in the river bed, the work being done mostly while the river was frozen over and the water low. Piles were driven in the river bottom and sawed off at the gravel surface, and on them the cribs were built. These cribs were then extended to a height of about 5 ft. above high-water level and filled with rock. They were sheathed with sheet iron on the up-stream end to protect them from ice. Derricks were used in assembling the steel spans. During this season, also, a pile approach to the bridge, 400 ft. long, was built, and several other smaller pile trestles and framed trestles. Construction was halted in the midst of the working season in 1907.

In the spring of 1908 construction was begun again. It was desired to have the job completed by the following October 1, the end of the working season. All the pipe was not then on the ground, and what was on hand was not continuous. That is, sections of pipe were missing here and there. As there were so many different kinds of pipe in this line, and as extra pieces were few, it was generally impossible to use sections of pipe interchangeably, therefore work could be started only at certain places. In the course of the work, it was necessary to start laying pipe at four different stations. An error in surveying would lead to awkward consequences where any of these headings joined, as well as at angle points in the pipe line. As there was no heavy machinery or plate for making pipe of this size in the country, and there would not be time to send "outside" for extras, it was necessary to be very careful in surveying.

All the pipe on hand was first measured up carefully and a relation established between actual measurements and those given on the blue prints. An offset line was then run paralleling the located line at a distance of 20 ft. As the seasonal thaw had loosened the original hubs so much that they could not be relied on, measurements were begun from a point on one of the bridge piers. Hubs were driven about 99 ft. apart, and measurements were taken from plumb-bob strings held from tripods. This was done on the side-hills as well as the flats. A standard pull of 15 lbs. was used, the same as had been used in measuring up the pipe on hand. Corrections were made for temperature variations. Levels were run over the hubs, and horizontal distances were computed from the slope measurements and elevation differences. This system resulted in giving a first-class base line, which could be absolutely relied on in setting grades or starting points. Grades were "shot in" by transit. Points were set along the edge of the pipe trench, and were transferred to the bottom, when needed, by using a large wooden square and a carpenter's level. Bench-marks were set every 50 ft. in elevation. Levels were determined by running ahead for half a day and then tying back to the starting point.

In construction, it was frequently found advantageous to depart from the profile in order to avoid excessive excavation, and in these cases grade changes were made by shifting angle points.

Pipe was distributed along the line by a tramway. The cars were pulled by horses across the flat and by hoists on the hills. Of these hoists, two were run by steam, and one by electricity. Signals were given by use of a wire attached to a spring pole. A telephone system also helped in signalling and general communication. Turn-tables were installed on which to change the sections of pipe end for end when necessary. Steel-frame cars were used. In hoisting, a bridle was attached to the end of the pipe, and the cable was shackled to this bridle. When the pipe was at the spot desired, the cars were chained to the rail, and the pipe, with the hoisting cable still attached, was rolled into the ditch. This held the pipe from getting away on the side-hill, and the cable always had so much spring that no harm was done to the engine.

The fitting-up gang used ratchet jacks in fitting up the pipe. The section was first slid down to the last section already connected up and then turned until it was right side up. The "front," or free end, was then raised until the top holes at the back end could be caught by drift-pins to the last section. Guide-straps were then bolted on at the joint, and the front end was lowered gradually. As the front end came down, the joint was sledged and the guide-straps were tightened as necessary. When the joint was entered all around, a ratchet turnbuckle was attached and used to pull it together. Fitting-up bolts were put in every third or fourth rivet hole. Four or five sections of pipe per 10-hour shift was an average for the fitting-up gang.

Rivetting, caulking, and drilling were done with pneumatic tools. Air was furnished by 8 x 8-in. Clayton air compressors run by 15 h.p. 3-phase motors. One air compressor would furnish air enough to operate a rivetting hammer, caulking hammer, drills, and air dolly, with not much to spare. The compressor outfit were mounted on platforms and moved from place to place as desired. The rivetting of the holes in the

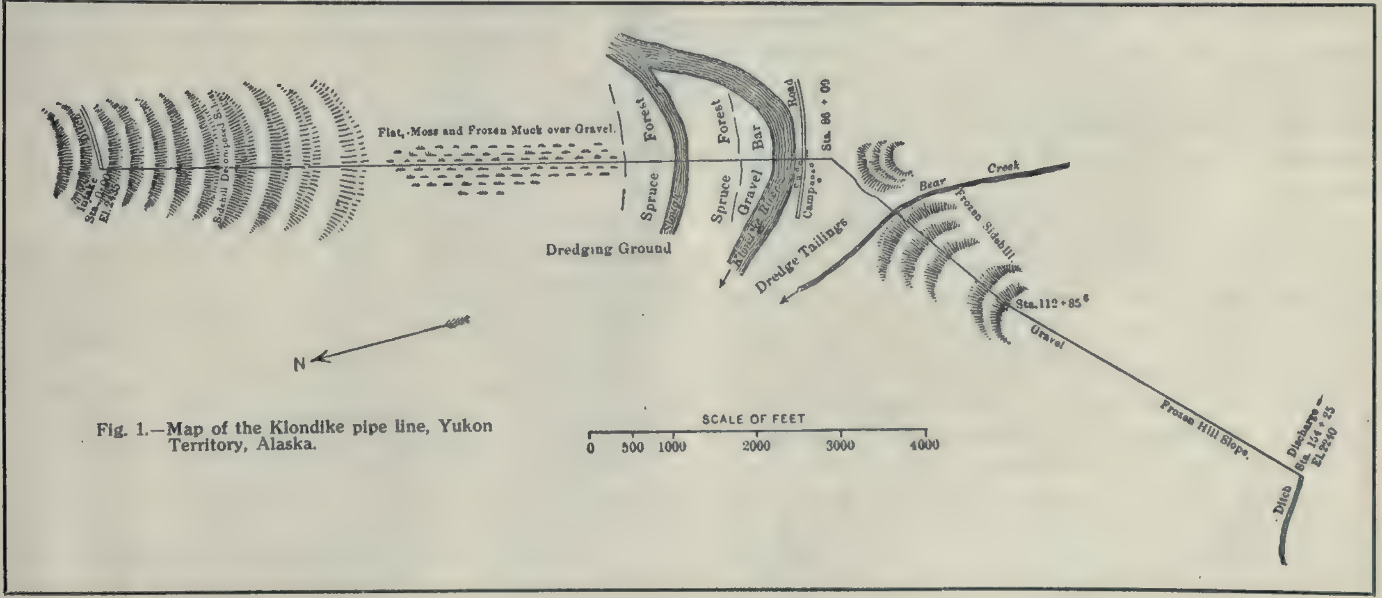


Fig. 1.—Map of the Klondike pipe line, Yukon Territory, Alaska.

bottom of the pipe was done from the inside, and of the upper holes from the outside. Air dollies were used in holding on inside the pipe and spring dollies on the outside. Each rivetting gang consisted of a riveter, bucker-up, heater, and passer. An average day's work was from 160 to 180 1-in. rivets, when conditions were good. Fitting-up bolts were used liberally, and the joint was well sledged before driving each rivet. All castings were hand-riveted to the pipe, the rivetting being done on the inside.

The expansion joint castings were frequently found to be too large for the pipe. In such cases the pipe was heated by a blast lamp and belled out with hammers to fit the casting. Rivet holes in all castings were drilled in the field after assembling. All caulking was done with rounded-edge fullers, the square tool being dispensed with. The rivetted pipe was caulked on the outside only, the lap-welded pipe was caulked both inside and outside. Rivets were inspected with a 1-lb. tapping hammer.

The pipe was coated on the outside with a red mineral linseed oil paint and inside with a quick-drying black paraffin paint.

The wood stave pipe was of California redwood staves thoroughly seasoned. It was laid in a trench 2 ft. deep, and, when completed, was back-filled to a depth of half the diameter of the pipe, so as to give a good bearing.

The intake penstock was equipped with overflow and turn-out, as was also the discharge box. The discharge box was located on a shaded side-hill on frozen clay. This condition made necessary considerable cribbing to protect it from the sloughing of the clay when it thawed consequent on the removal of its moss covering.

Timber was secured from adjoining leases and also from river drives. It was necessary to do considerable work to protect the river banks from undercutting in the vicinity of the bridge, as they were of loose gravel, loam and moss. Piles were driven and shear cribs put in along the river bank above the bridge. Protection cribs were also put in above the pile bents on the bridge to take the brunt of the ice pressure and to break up the ice stream.

Frozen muck, reaching to a depth of 45 ft., was encountered between Stations 84 and 90. Shafts were dug to gravel foundation and trestle bents were put in at intervals of 32 ft. Between Stations 90 and 93, a heavy cut through dredge tailings and solid rock was necessary. This was just at the base of a hill which was covered with frozen muck. The digging of this section was delayed until as late as possible so that the extreme cold would keep the overburden on the slope above from thawing on exposure, and consequent sliding.

A small spot of frozen clay was encountered at about Station 107, and the depth of good foundation being unknown, a corduroy of spruce trees was laid on the frozen clay in the bottom of the pipe trench and this was covered with about 2 ft. of gravel. A bulkhead was built around the pipe above this place to shut off all seepage and leakage, and a drain was run off to the side. The pipe was back-filled and the surface covered with moss again. Apparently, the foundation remained frozen, as no settlement was noticed.

Although work was begun at the camp about April 1, it was not until abuut May 15 that all the snow was off the ground and it was possible to work to the best advantage. A night shift was put on about May 15 and continued until October 1, by which date the pipe was all laid. The long days of the extreme northern latitude made lights unnecessary on the work until August 1. After that, a system of arc and incandescent lights was installed, which worked very well. The missing sections of pipe began to arrive about July 1, and from that time onward operations were rushed. A force of 350 men was used to push the work to completion. The different headings of pipe were connected up at the expansion joints. This was effected by sliding the outside ring of the expansion joint back on the pipe and then pulling it up to position after the pipe had been lined up.

A tabulation was made showing the space to be left open at the expansion joints at various temperatures, so that they would not close during the hottest or open in the coldest weather. This was followed in setting the joints. Gages were wired on at each expansion joint so that unequal expansion or contraction could be noted and steps taken to prevent it. The coupling bolts for each expansion joint were set so that the lap in each joint could not be less than 1-in. Reference points were also put in on each 500-ft. section of pipe, so that movement could be detected. Anchors were put in at every angle point. These were generally either bulkheads of timber against the pipe, used as thrust anchors, or cables around the pipe attached to "deadmen." When possible, at the angle points, a timber crib was put completely over the pipe and filled with rock. The high cost of transportation and the character of the foundation made concrete anchors out of the question. The only timber available was white spruce, which was soft and brittle, and had to be used with a high factor of safety in all structures.

Some trouble was experienced from the lap-welded pipe. Two makes were used on the job. One, an American make, was perfectly satisfactory, but the other, a German make, was not. One section of the second kind cracked along the weld for a distance of 10 ft. on being dropped into the pipe trench. This was patched and reinforced, and gave no trouble in operation. Another section of this pipe burst in testing under 835 ft. head. Examination showed a flaw in the metal. When it burst, the water was shot out to the side of the pipe line and little damage was done. This was the extent of the trouble with the line in testing.

In operation, the quantity of water flowing through the pipe fluctuated considerably. As the difference in elevation between intake and discharge was 195 ft., this variation caused great fluctuations in the water level in the pipe at the intake end, there being no regulating gate at the discharge end. When little water was flowing, it ran in a very rapid stream down the bottom of the wood stave pipe at the intake end. This had the result of rapidly wearing out the bottom staves, so that considerable patching had to be done.

Bulkheads were put in at each end of the pipe and all other openings were closed as soon as the pipe was thoroughly drained. Thus the air circulation inside the pipe was shut off and the subsequent snow formed a blanket which protected it from the extremes of the winter temperature. It was found that with an air temperature of —30 deg. or —40 deg. F. the temperature inside the pipe was only about —5 deg. F. In operation, the pipe is drained at the close of the working season, about October 1, and opened again about May 1.

The peculiar and therefore the most interesting feature of this work was, as noted before, the study of foundations and the best styles of substructures to be used in the frozen ground. In places in the North, piles of sawdust have been placed on the moss, and buildings put on this foundation. When water is kept away, this makes a very good foundation, as the saw-dust protects the moss and the frozen ground below from heat and consequent thawing, thus insuring stability. On this same principle, in running a road or railroad grade across frozen ground, it is best not to cut but rather to make fills on top of the moss. Thus, on a railroad grade near Nome, a fill was made of peat cut from the surface of the tundra. When dried out and packed this gave no more trouble—until it burned up—where as a cut in frozen ground is but an invitation to perpetual trouble from slides and settlement. In flume substructures, on the Yukon Gold Company's line, on frozen side-hills, cripple bents were tried and discarded in favor of level mudsills set in the "frost," about 2 or 3 ft. below the surface at the down-hill end. These were mossed over and remained frozen unless excessive leakage thawed the ground.

Mr. A. C. Strong, of the Yukon Gold Company, developed a type of structure which suited the foundation very well. He used piles driven into holes previously thawed out by steam points. The steam point is a strong pipe, at one end of which steam is introduced. The opposite end is rounded and a small hole left through which the steam may escape. This point is started into the frozen ground and is pounded down with a hammer as fast as it thaws through the "frost" in its way. These steam points were developed and used to considerable advantage in mining the frozen gravel. In substructure work, the steam point is used until the "frost" is thawed to the desired depth. It is then removed and a pile driven into the thawed-out hole. As the surface moss is disturbed hardly at all in this process, the pile immediately freezes in and remains in this condition. At last reports, pile substructures, such as these, were giving good service. This appears to be the cheapest form of substructure as yet devised for use in ground frozen to any considerable depth.

The foregoing work was done by day labor by the Yukon Gold Company, Mr. O. B. Perry, general manager; C. A. Thomas, M. Am. Soc. C. E., resident manager; H. H. Hall, Assoc. M. Am. Soc. C. E., superintendent of ditch construction, and in general charge of surveys; Mr. C. G. Newton, superintendent of pipe lines; and the writer, division engineer and general foreman.

Dry concrete, i.e., a mixture of aggregates and cement without water, should not be employed in laying concrete under water.

Builders' acid, which is equal parts of muriatic acid and water, will remove spots of mortar on brick or stone work, but is not the right material for cleaning stone that is begrimed from smoke and dirt. To accomplish this, apply to the surface, with a long-handled fibre brush, a strong solution of caustic soda or pearl ash. Let it remain on for about fifteen minutes, then wash several times with clear water, using a stiff brush or broom for the purpose. If this will not be effective enough, scrub the stone with a stiff fibre brush, using soft soap and concentrated lye and sand, allowing this to remain on the stone until nearly dry, then rinse with clear water, using a brush to remove the cleansing material.

Elevated Steel Water Tower at St. Thomas, Ontario

THERE has been completed recently at St. Thomas, Ont., what is claimed to be the largest elevated steel water tower in Canada. This elevated tank was installed by the Board of Water Commissioners of St. Thomas for the extension of the city water supply. The following figures furnish some idea of the exceptional proportions of the structure: capacity of tank, 500,000 Imperial gallons or 600,000 United States gallons; height to top of tank, 131 ft. 2¾ in.; diameter of tank, 46 ft.; height of shell, 37 ft. 3¾ in.

This tank is high enough to give an average pressure of about 48 lbs. per sq. in. in the mains at the tower site, with a possible minimum pressure of 35 lbs. and maximum of 56 lbs. per sq. in. The inlet and outlet pipe to this tank is of standard weight, 14-in. cast iron pipe. The pipe is protected from freezing by a wooden frost jacket having four thicknesses of lumber and building felt. The tank is kept full at all times by the use of a Golden-Anderson Controlling Altitude valve on the 14-in. inlet line. In addition to automatically keeping the tank full at all times this valve may be opened from the pumping station at any time by means of an electrical attachment.

Ready access to all parts of the structure is provided by means of a separate steel ladder as shown in the illustration. From the balcony a ladder reaches to the top of the cylinder. This ladder is attached to a trolley which permits it to revolve around the entire tank. In the same manner a revolving ladder is fastened to the heavy cast iron finial at the apex of the roof. This complete system of ladders makes repainting a simple matter, and permits of thorough inspection of the tank and tower at any time.

The completed tower at St. Thomas.

The twelve posts making up the tower are of built-up section consisting of two 15-in. channels weighing 50 lbs. per foot, with one cover plate which varies in thickness from 13-16-in. at the bottom to 7-16-in. at the top. The columns are laced on the other side, making a section which may be readily painted at any time.

The horizontal members in the tower are made of two 6-in. channels weighing 8 lbs. per foot. The rod bracing between columns varies from 1¾-in. rods at the top to 2-in. rods in the bottom panel. A heavy system of rod bracing is provided at each strut level to keep the vertical tower rigid under wind pressure. Clamps are provided about the wooden frost casing which take the stresses from these rods without in any way distorting the frost case.

The tank itself is made of ½-in. plate in the lower part of the cylinder and diminished to ¼-in. plate at the top. The bottom of the tank is made with double-lap rivetted joints, the metal being ⅜-in. thick at the connection to the cylinder and 7-16-in. thick at the extreme bottom. At the connection of the posts to the tank a heavy structural steel balcony or walkway, 30-in. wide, of ¼-in. plate and having 6-in. x 4-in. x ½-in. and 4-in. x 3-in. x 5-16-in. angle stiffeners, is provided. The roof of the tank is made of ⅛-in. steel plates, rivetted and caulked watertight. The roof is supported on 24 steel rafters which rivet rigidly to the tank shell. The roof projects beyond the tank far enough to carry all water well beyond the balcony.

The bottom of this tank is made to a special curvature used exclusively by the firm manufacturing this structure. The bottom in section is a three-centered curve, which connects to the vertical cylinder on a tangent to this curve. In this design there is no other stress transmitted to the cylinder than in the commonly used hemispherical design. The advantage of this bottom is that it is more shallow than a full hemisphere, the total depth being 18 ft. 2 in., while the hemisphere would be nearly five feet deeper. This particular curve is selected because it gives the greatest capacity for the amount of steel used and reduces the stresses in the bottom to a minimum; furthermore, it gives sufficient slope to the bottom that no sediment will remain in the tank. This type of bottom is used extensively in railroad work where it has been adopted as standard by several of the largest companies.

Each of the columns supporting this tank is anchored by means of two 1¼-in. anchor bolts to a massive block of concrete. The footings measure 5 ft. square at the top and extend to a depth of 4 ft. 9 in., where they are 11 ft. 6 in. wide by 13 ft. 6 in. long. Each foundation is surmounted with a finished block of concrete 4 feet square.

The requirements of the system were determined by the Board of Water Commissioners and incorporated by Mr. M. Ferguson, city engineer of St. Thomas, in a specification. The complete water tower, exclusive of foundations, was built for about $27,000. The design was submitted by the Pittsburgh-Des Moines Steel Company, of Pittsburgh, Pa., who manufactured and erected the structure.

Large Reinforced Concrete Pier at Halifax, N. S.

EMPLOYMENT of 24-in. piles 75 ft. long, with a specially designed pile driver to place them; use of a special cement with a minimum of alumina to resist the chemical action of sea water and a timber sheathing at the water line to protect the concrete from frost action; the casting of the diagonal brace piles with a camber of from 2 to 5½ in. to allow for the bending moment of the pile's own weight—these are among the features of the new pier 2 under construction for the Intercolonial Railway at Halifax, N.S.

General Features

The pier, which when completed will be 686 ft. long and 235 ft. wide, and will carry a shed 677 x 198½ ft., is the first of a series of four large piers proposed to replace four much smaller ones. The general plan shows the relative location of the old and new piers and their track connections. By this plan piers, 2, 4 and 5 would be removed and pier 3 would be lengthened and widened to form the new pier 3. Work on pier 2 was started in the fall of 1911, and when the 1913 season had closed all but 120 ft. of the pier had been built and a start had been made on the shed. The shed will be a two-storey structure, the lower floor being devoted to cargo and mail. The upper floor will be fitted up and used for a time for passengers and baggage, with the intention of subsequently changing it for freight use only.

Reinforced-concrete piles were selected as most suitable for the foundations. Borings showed solid rock at a depth varying from 52 to 68 ft., overlaid with from 2 to 12 ft. of hardpan and from 5 to 27 ft. of soft mud. This meant an average height of 75 ft. from rock to track level. The track level was fixed at 15 ft. 8 in. above extreme low water. Owing to the small height available above low water for diagonal transverse bracing, and the great depth from low water down to rock, it was thought that such a system of bracing would not greatly increase the stability of the pier and its ability to withstand shocks from vessels. It was, therefore, decided to use reinforced-concrete brace piles driven at an angle of 3 on 1. This is believed to be the first application of such a system of bracing to reinforced-concrete work. As a further means of stiffening the pier it was decided to make a bank of dredged material under the pier so as to increase the amount of material through which the piles would be driven.

Special Cement

Two causes militate against permanency of concrete in salt water in this latitude. One of these is frost action, the water absorbed by the concrete at high tide freezing at low tide and causing the surface to spall away between the tide levels. The other is chemical action, which takes place between certain salts, notably magnesium sulphate, and constituents of the cement. Investigations have shown that this magnesium sulphate reacts with the free lime liberated during the setting of the Portland cement to form calcium sulphate, which in turn reacts with the calcium aluminate of the cement to form a sulpho-aluminate of lime. This last substance swells considerably on hydration, thus disintegrating the concrete, and it is evident that the extent of the disintegration varies directly with the alumina present in the cement.

To resist this chemical action arrangements were made with the cement manufacturers to supply cement with a maximum of 6.3 per cent of alumina, which was the lowest they could produce. It was also decided to use proportions of 1:1½:3, so graded as to produce as dense and non-porous a concrete as possible.

To withstand frost action it was decided to sheathe all concrete within the ordinary tidal range with timber. In order that this timber might be durable it is creosoted, and to prevent chemical action between the creosote and the cement the surfaces of the planks are coated with pitch.

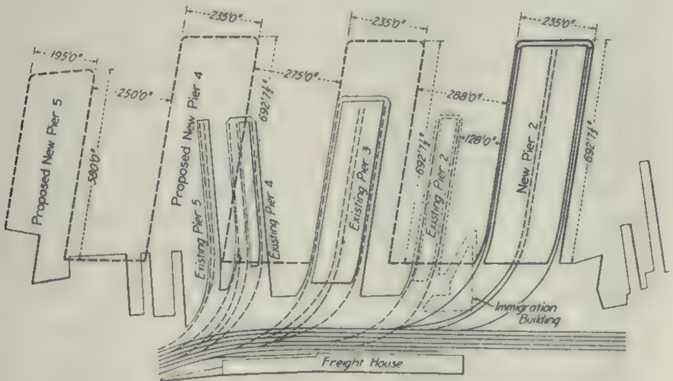
Loading

Live loads of 1,000 and 500 lb. per square foot for the first and second floors respectively were assumed in working out the details of design. The spacing of the piles was determined by the spacing of the shed column, which in turn governed the load for each pile to carry. As the drawings show, the transverse spacing of the columns is 39 ft. 6 in.; the longitudinal spacing of bents is 18 ft. Three vertical piles and one brace pile carry each interior column and single intermediate piles carry the floor. This arrangement gives a distributed load of 80 or 90 tons per pile. To keep the load on the rock well within a maximum of 35 tons per square foot the size of piles was fixed at 24 in. square.

Eight round rods, from 1 to 1¼ in. in diameter, according to the length of the pile, and laced every 12 in. with ¼-in. rods, form the reinforcing. This lacing is spaced closer at the heads of the piles, and at the tapered points additional rods and spiral hooping are used. The points are 3 in. square and are not shod. To facilitate bonding with the decks the rods are allowed to project 3 ft. beyond the head of the pile, and in each pile there is also set a staple, made from a 1¼-in. square bar 7 ft. long, to aid in handling.

Similar reinforcement is used in the brace piles, but in order that when the pile is built into the pier and subjected to an axial compressive load of 80 tons the stresses due to this load and the bending moment of the pile's own weight may be uniform it is cast with a slight camber. The amount of this camber varies from 2-in. for 45-ft. piles to nearly 5½-in. for the longest, which are 77 ft. The brace piles are driven in such positions that their heads can be built up along with the vertical piles under each shed column. In this way the full value of the pile is thought to be obtained without danger of its breaking up the decks.

A feature of the design of the shed is the use of expansion joints in the roof. Owing to the fact that only a part of the second floor will require heat, while the entire first floor and the baggage spaces which occupy the outer bays on each side of the upper floor for about five-sevenths of its length will not be heated, it was found necessary to provide these expansion joints to relieve the stresses that would be set up in the columns by the unequal heating of the building. Seven transverse joints are provided, 90 ft. on centers. They extend over the interior bays only, and are formed simply by cutting the slab and leaving a ½-in. space, the longitudinal beams thus cut being designed as cantilevers on each side of the joint. A ½-in. steel plate laid horizontally and bedded into grooves in the adjacent edges of the slabs at each joint secures their alignment.

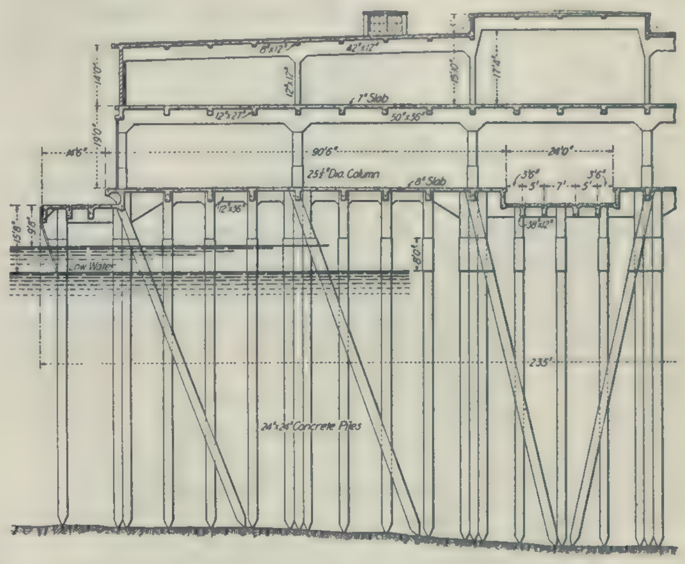


General plan of existing and proposed ultimate pier development.

When the contract was let in September, 1911, work was at once started on the removal of the old piers occupying the site. This took all of the following winter, a diver being required to help remove many of the limnoria-eaten stumps of wooden piles. It might be mentioned that even creosote does not seem to be entirely effective in these waters, as piles treated with this preservative and driven about four years ago showed signs of attack.

Pile-Casting Yard

Meanwhile preparations were being made for casting the piles. At the east end of an area 800 x 600 ft. graded level for the purpose a gravel-excavating and concrete-mixing tower was erected. On this tower, which was about 92 ft. high and was carried on wheels so that it could travel north and south across the end of the yard, was placed the machinery for excavating, screening and crushing the gravel, mixing the concrete and conveying it by a cableway to the pile molds. At the top of the tower was a winch which operated a dragline bucket. This bucket emptied its contents of sand and gravel into the hopper. The material passed over a grizzly and all stones that did not pass through were conveyed to a jaw crusher. All of the material then went over 1-in. and ¼-in. screens. Material passing through the ¼-in. screen went into the separate sand bin. That which did not pass through the 1-in. screen was taken to a second crusher. Chutes from the sand and stone bins led to the mixer platform, wherein each batch was measured before being put into the mixer. Each batch of about 1 cu. yd. was discharged by means of a chute into a bottom-dump bucket which travelled along a cable stretched from the mixer tower to an anchor tower at the west end of the yard. This tower was also mounted on wheels and tracks and was moved along with the main tower.



Transverse half-section of pier and arrangement of batter piles.

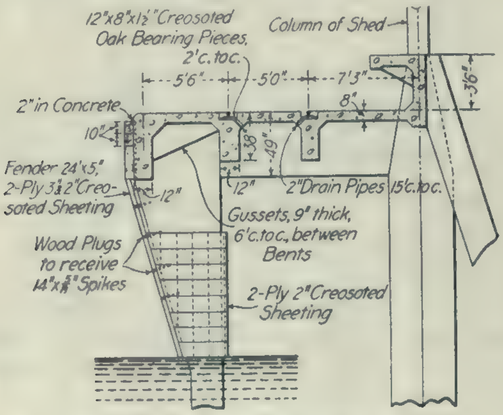
A timber pier 1,000 ft. long and 22 ft. wide, increasing in width to 38 ft. for 85 ft. at its outer end, was built for the landing of supplies and the shipping of the concrete piles. A 30-ton steam derrick at the outer end of the pier loads the piles on scows.

The pile yard was divided into ten sub-yards running north and south. The piles were cast, usually in pairs, with the axes east and west, parallel to the cableway. Transverse tracks ran between the piles and a longitudinal track ran the length of the yard on the outside. A locomotive crane handled the piles between the yard and cars on the transverse tracks, another transferred them to the longitudinal track, and the 30-ton steam derrick above mentioned disposed of them at the outer end of the pier. In handling these piles they were always supported one-fifth of the distance from each end.

Simultaneously with these operations a special pile driver to place the piles was being designed and built. It took longer than was anticipated to build and fit up this pile driver, and it was not until January, 1913, that everything was in readiness for driving the piles.

Placing and Driving Piles

The method of placing and driving a pile was as follows: The driver was first placed in correct position by means of cross-ranges, and the three spuds were lowered to anchorage. The pile having been brought with others alongside on scows, straps were placed around it at points one-fifth of the distance from each end, and the pile was lifted in a horizontal position by one of the derricks and swung around in front of the driver so that the head lay at the bottom of the lead. The swinging of the derrick was accomplished by manipulating the forward spuds. The pile cable being made fast to the staple projecting from the pile head, the order to hoist was given, and as the derrick fall was lowered the pile was gradually hoisted into a vertical position, the derrick straps being disengaged as they slackened off. The leaders were then moved until the pile, hanging in them, was centered in exact position. Then the pile was lowered, its own weight being sufficient to penetrate the soft mud overlying the hardpan. When the thickness of the mud was equal to about a third of the length of the pile it was found that the piles would stand where placed without any bracing; as a rule, however, the pile was braced while the hammer was being adjusted on its head.


12"x8"x1½" Creosoted Oak Bearing Pieces, 2' c. to c.
Column of Shed
5'6"
5'0"
7'3"
3'6"
2" in Concrete
8"
10"
38"
49"
Fender 24'x5", 2-Ply 3" & 2" Creosoted Sheeting
12"
12"
2" Drain Pipes 15' c. to c.
Gussets, 9" thick, 6' c. to c., between Bents
Wood Plugs to receive 14"x⅝" Spikes
2-Ply 2" Creosoted Sheeting

Fender and other pier details.

Three separate cushions were used between the concrete of the pile and the ram of the hammer. On top of the pile was placed a 3-in. spruce plank. On this rested a cast-steel follower about 4 ft. high consisting of a hollow cylinder or post with top and bottom flanges. The bottom flange was flat, and in it were eight holes through which the projecting rods of the pile reinforcement passed and were protected. The top flange had cast on its upper side a rectangular depression in which was placed a hardwood block about 15 in. thick, bound round with a steel band. This block received the direct blows of the hammer and had to be frequently renewed; sometimes it would last for two piles only, while at other times it would stand the hammering of twenty. Usually the cause of failure was the breaking of the steel bands, but on one occasion the block was found to be on fire and badly charred owing to the heat generated by the force of the blows.

There were great differences in the amount of driving required. Where the quantity of hardpan was small the pile would often come to a stop after 200 or 300 strokes, while at other places nearly 1,800 blows would be required. The rate of penetration through the hardpan was small, the advance in the last strip being in many cases not more than ¼-in. per blow.

Little damage was done to the piles in driving. Only two out of 1,550 had their heads smashed, and these were among the first dozen driven, the cause being a continuation of the hammering after the pile had reached rock. No harm was done, however, by a few blows after the penetration had stopped. In order to find out what was happening to the point of the piles some of them were pulled out after having been driven to refusal. In only one case was there any damage done to the point, and this damage is believed to have been due to a sharp point of rock, which spalled off a small piece of concrete.

Usually about twelve piles were driven per ten-hour day, but when there were no delays as many as eighteen were placed.

Testing the Driven Piles

In order to test the bearing power of the piles after driving a load of 120 tons was supplied on the head of one of the piles and allowed to remain there for three hours. No settlement took place. The method of applying the load was as follows: The pile selected for the test was driven close to the cribwork bulkhead. Two 12 x 12-in. timbers were placed across the pile heads, bearing on a hardwood fulcrum. The inner ends of the timber were held down by a bracket firmly bolted to the base of the cribwork, and on their outer ends was placed the 16-ton steam hammer. The ratio between the outer and inner lever arms being 6½ to 1, the total load applied to the head of the pile was 120 tons. Other tests were made as the work proceeded, and in no case has any settlement of a pile been detected.

To get forms of the necessary strength on the short lengths of piles projecting above the water level, 4 x 8-in. horizontal walings were bolted on each side of the pile as soon after driving as possible, and on these rested the vertical forms for the building up of the pile to deck level. The bottom planks of the beams were carried on the pile extension form and were further supported by diagonal shores from the walings on the piles. Slight settlement of the forms took place on the pouring of the deck concrete, but in no case did any serious failure occur. It was found that by filling the pile extension molds at least twenty-four hours ahead of the pouring of the deck the settlement in the forms was reduced considerably.

Deck Joints

It was impossible to concrete such a large area of deck without having joints between different days' work. No joints, however, were allowed between beams and slabs. The beams having been designed as T-beams, the slab was always poured immediately after the filling of the beam supporting it. The joints at the end of a day's work were arranged so that the vertical face so made would be perpendicular to the compressive forces in the beam or slab at the joint, and they were made where the shearing stresses were a minimum. In the case of the longitudinal girders the joint had to be made at one side of the floorbeam carried by the girder, at a point where shearing stresses would occur. The joint here was made with a horizontal berm to give a bearing to the central portion of the girder, and care was taken to have some of the diagonal rods pass through the joints. For the deck the concrete proportions were 1:2:4, the stone being crushed gravel passed through a 1-in. screen. The concrete was mixed so that it would flow easily around the steel rods, but not so wet as to show an excess of water. Special care was taken to see that all steel was properly embedded in the concrete, and where there was any doubt of the concrete being able to work round the rod a batch of fine concrete, in which the stone was under ¼-in. in size, was used instead of the ordinary mixture.

About 120 ft., as previously stated, remained to be added when the work was shut down last winter. The temporary finishing off of the deck beams and slabs at this point has been so arranged that there will be no line of weakness when the pier is completed. This is being done by hooking all projecting reinforcing rods and by the addition of some special rods to take care of the continuous beam action. Beam seats have been built on the east side of the pile of the bent in question to carry the shore ends of the beams of the portion still to be built.

Personnel

The entire work is being done by the Nova Scotia Construction Company, of Sydney, N.S., under the management of Hamilton Lindsay, vice-president of the company. John Kennedy, consulting engineer, of Montreal, is the designer and chief engineer, and is represented on the work by A. F. Dyer, resident engineer. The major part of the foregoing article was prepared from a paper presented some time ago by Mr. Dyer to the Nova Scotia Society of Engineers, and rearranged by the Engineering Record.

Hydro-Electric Development at Cedars Rapids, Que.

Progress Report

THE progress of the hydro-electric plant now being constructed at Cedars, P.Q., on the north shore of the St. Lawrence, by Fraser, Brace & Company, for the Cedars Rapids Manufacturing & Power Company, is shown by the following figures of work completed:

	Aug. 23 1913	Dec. 1 1913	May 1 1914
Rock excavation	21%	23%	58%
Earth excavation other than stripping and trench work	43	60	73
Earth excavation in trenches and ditches, and stripping seats of banks	36	84	Complete
Transporting and placing excavated rock	20	28	62
Stone protection	2	3	5
Transporting and placing excavated earth	43	63	77
Concrete in power-house substructure	16	26	69

The present plans are for a development of 100,000 horse-power, with later an additional 60,000 horse-power. There are 1,500 men engaged in the work of construction, and about ten miles of temporary lines are laid for the purpose of transporting the material excavated from the canal, at the end of which is situated the power-house. The canal is a great undertaking, the excavated material being utilized to form the banks. When the work of earth removal is completed at the upper end of the canal, the equipment will be moved further down the canal to reinforce the working equipment at that point. In the south bank a concrete structure with gates constitutes a spillway and ice sluice. This will dispose of surface ice, the canal below it being further protected by booms.

The additional development will be on the north side of the present power-house. In the construction of this structure a large crane is used to convey buckets of concrete from trains, into the foundations over which it projects. The rock crushing, concrete and mixing plant is located considerably to the north of the power house, so that the progress of the work in either case is entirely independent of interference by the other. The power-house has ten tail-race openings, one for each unit, with three small openings for the exciter units. Work has now been started to bring the tail-race down to grade as some excavating still remains to be done. This work, however, involves nothing beyond straight disposal of excavated material.

Large cranes are used for handling the heavy parts of both water wheels and generator units now being installed. Tracks entering the building make it possible to move such trainloads of machinery almost to the identical spot of installation, the cover plate of each water wheel has a diameter of 20 feet and weighs about 120,000 lbs. The transformer-house is 800 feet distant from the north end of the power house, and later part of this will be utilized for the extension of the power-house. An erecting tower enables the concrete to be elevated and distributed, the concrete being placed at all points of the building by means of a chute.

The Unit Construction Company, of St. Louis, Mo., are constructing the power-house units and transformer-house superstructure. The Phoenix Bridge and Iron Works, Montreal, are supplying the structural steel work.

The company have let a contract to Simpson Brothers, Montreal, to dredge the material at the head of the canal and to dredge the forebay immediately above the intake. There is involved the removal of about 175,000 yards of material, and the work is to be completed before the end of the year.

The storms of last winter proved that concrete poles are far better than wooden ones for holding up telephone and telegraph wires. Not one concrete pole on the Pennsylvania system was blown down, although hundreds of wooden ones were broken.

One of the novel forms of entertainment at the recent convention of the American Society of Civil Engineers in Baltimore was a luncheon 71 ft. below the street surface in the 29-ft. Jones Falls diversion tunnel, the largest drainage tunnel in the world. Calvin W. Hendrick, chief engineer of the Baltimore Sewerage Commission, conceived the idea of the underground banquet. The floor of the tunnel had been covered by boards, and twenty tables were arranged for the guests.

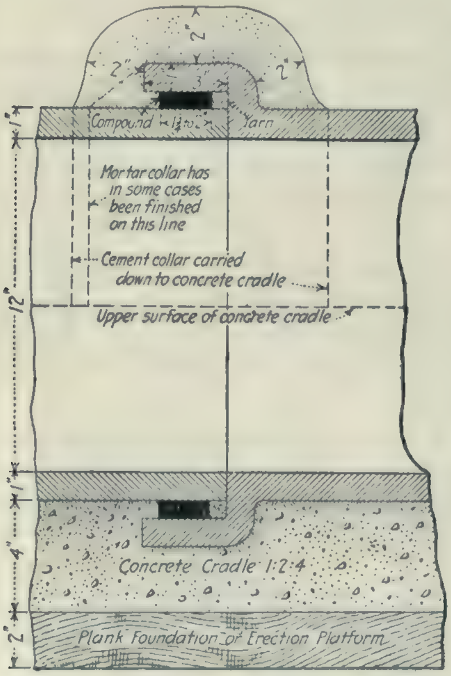
Water consumption in London, Ont., during 1913 was 92 Imp. gal. per capita, according to the last annual report of the water commissioners of that city. Figured on pumping station expense the cost was 16.6 cents per 1,000,000 Imp. gal and 6.9 per 1,000,000 gal. raised 1 ft. About 84 per cent of the pumping is done electrically. The services now number 13,978, of which 2,115 are metered. More than 450 meters were installed in 1913, against only 376 during the previous year.

Water-Tight Sewer-Pipe Joints

By E. J. Fort[*]

THE drainage for several square miles of territory in the southern portion of Brooklyn, in the neighborhood of Coney Island, Sheepshead Bay, Jamaica Bay, etc., where surface elevations are low, provide for a separate system of sewers, in which, in most cases the sanitary sewers are below the level of ground water, and in all cases the domestic sewage must be pumped. This made the matter of water-tight pipe joints one of great importance.

At the beginning of this work, the Bureau of Sewers had had no experience in the use of the various compounds offered on the market for this purpose, and had little information in regard to their merits. It was thought best, therefore, to depend upon extreme care in the use of cement mortar with a hemp or oakum gasket for the desired results until the various compounds available could be thoroughly tested. The first few contracts let, therefore, provided for cement-mortar pipe joints. The mortar was mixed in the proportion of one to one and was liberally used. In most cases, where pipes have been laid below ground-water level, they have been laid in a concrete cradle, and where the pipe joint is not buried in the cradle it is inclosed in a cement collar at least 2-in. thick outside the bell. When the contractor and inspector can be relied upon for careful and conscientious work, a pipe joint made in this manner and allowed several hours to set before water is allowed to rise over it will be practically water-tight under heads of water as great as 8 ft. These individuals, however, cannot always be relied upon, and a very slight injury to a joint made in this manner will produce a leak.


2"
2"
3"
2"
Compound
1¼ to 2"
Yarn
1"
Mortar collar has in some cases been finished on this line
Cement collar carried down to concrete cradle
Upper surface of concrete cradle
12"
1"
4"
Concrete Cradle 1:2:4
2"
Plank Foundation or Erection Platform

Sewer-pipe joint made with a compound and protected by a cement-mortar collar

Use of a Compound for Joints

A compound suitable for sewer-pipe joints should possess the following properties:

(1) It should show no deterioration when submerged in either fresh or salt water or in alkaline or acid solutions of moderate strength. Domestic sewage usually has an alkaline reaction, but frequently in the neighborhood of factories it has an acid reaction. In certain places, ground water is heavily charged with alkali. The life of the sewers as water-tight structures will be measured by the life of the joints.

(2) It should melt and run freely at temperatures not greater than 250 deg. F. It should be poured at a temperature of approximately 400 deg. F. to make certain that the joints are thoroughly filled. It is not usually possible in wet trenches to keep the ends of the pipes dry and the temperature at which this material is poured should not be so high that steam is rapidly generated where it comes in contact with moisture with the result that either the compound is made porous or the runner is blown out.

(3) It should adhere well to the glazed surface of stoneware pipes so that slight movements in these pipes after the joints are poured will not produce leaks.

(4) At temperatures which prevail in and about sewers laid under such conditions, the compound should be elastic enough to permit of slight movement without fracturing the pipes, but should not become soft enough to run out of the joints. Such movements very frequently occur in unstable soils.

(5) It should not be composed of materials which volatilize rapidly at comparatively low temperatures, so that men working with the ordinary skill and care of the average sewer contractor or contractor's foreman can use it successfully.

Every material on the market, samples of which could be obtained, was tested to determine the degree to which it possessed the qualities named. They were all found more or less defective, so that they could not be used with any assurance that they would produce permanently tight joints.

The various compounds in which sulphur is used were found to shrink upon cooling, either separating from the pipes or cracking so as to admit water. Compounds having certain oils as bases disintegrated rapidly when exposed to the action of alkalies, although they resisted the action of acids very satisfactorily. Certain compounds having bituminous materials (generally pure or nearly pure asphalt bitumens) as bases after they were modified in composition somewhat by the manufacturers, were found to resist the action of both acids and alkalies satisfactorily and possessed all of the qualities mentioned above. One of these compounds is manufactured in Brooklyn. Both "Jointite" and "Filtite," manufactured by the Pacific Flush Tank Company, have proved to be very satisfactory. The chemicals used in these tests were a 1 per cent solution of hydrochloric acid and 1 per cent and 5 per cent solutions of caustic potash. Samples were submerged five days in these solutions.

"Jointite" has been used for all sewer work of this kind which has been done in Brooklyn, with very satisfactory results. Experiments were also made in the laboratory with this compound to determine the highest temperature to which it could be safely heated and the length of time that such temperature could be maintained without danger of carbonization or destroying its flexibility. As a result of these experiments and later experience, the temperature at which it is poured is allowed to vary from 350 deg. to 450 deg. F., depending on the diameter of pipe and the season of the year. The compound is not held at this temperature longer than 30 minutes, and it is not allowed to be reheated and used after having once cooled.

---

[*] Chief Engineer, Bureau of Sewers, Borough of Brooklyn, New York City.

In the new Coney Island drainage system, and in other places in the Borough where the depth at which the sewers are laid below ground water is not more than 12 ft., as a general thing there is absolutely no leakage through the joints except in cases of accident or pure carelessness. We have found that the spur joint where a branch joins the main sewer is frequently carelessly made and admits water. Caps for house connection drains and for spurs are also frequently carelessly placed with the same result.

How the Compound Joints are Made and Protected

The accompanying sketch shows the manner in which pipe joints of this kind are made. A twisted hemp or oakum gasket of the proper size is first carefully rammed into the joint and occupies a depth of approximately ¾-in. A runner, usually a piece of old garden hose, is greased or smeared with wet clay and forced into the bell about ½-in. The ends are secured by a clamp in the usual manner so that the space for pouring is at one side of the crown of the pipe. The best results have been received by pouring so that the compound will run entirely in one direction about the joint, as it drives all the moisture ahead of it and completely fills the space between the bell and spigot.

In the case of pipes as large as 20-in. in diameter, where the space between the bell and spigot is very uneven, there have been numerous instances where the compound cooled so rapidly that it failed to pass the narrowest portions of the space and make a complete joint. For that reason, it is well to pour a full stream, so that it will entirely fill the space in which it runs. It is also well to remove the runners as soon as the compound has cooled sufficiently to stand alone, but while it is still hot so that any imperfections that may be found can be corrected by calking with compound hot enough to be plastic.

While it is possible to pour joints while the pipes are partially submerged, this procedure is not recommended, because of the great liability of producing imperfect work. It is our practice to run one-half of the joints before the pipes are placed in the trench. These joints are made with the pipes in a vertical position and without a runner. The pipes are then placed in position in 6-ft. lengths. At least a half-dozen joint runners are on hand and all the joints to be poured are made ready and poured at one operation without waiting for each one to cool so that the runner can be removed. In this way the danger of injuring the compound by keeping it at a high temperature for too long a time is lessened. The concrete cradle and the mortar collars are placed after the pipes have cooled. The former is used for the purpose of securing greater stability in unstable soil; the latter is used solely as a protection for the joint compound.

The repair of pipe joints several feet below water level, especially where, as in sandy soil, the inrush of water in the trench is great, is a very expensive operation and is always accompanied by the danger of injuring adjacent portions of the sewer. Such leaks are liable to continue for some time before they are discovered and to run up large bills for pumping before they are repaired. In my opinion, therefore, the cement collar in protecting the joint compound from direct contact with water or chemicals on the outer end, as it is protected on the inner end by the jute gasket, is worth all it costs.

The weights of "Jointite" used in jointing vitrified pipes of various diameters have been carefully determined. All of this pipe was double strength and had deep and wide sockets or bells. The weights were as follows:

Size of pipe, in.	Thickness of joint, in.	Depth of joint, in.	Weight of material per joint, lb.
6	⅝	1½	1.04
8	⅝	2	1.84
10	⅝	2	1.84
12	⅝	2	2.70
15	⅝	2	3.32
18	⅝	2.	3.80
24	1	2	8.50

Average specific gravity, 1.50.

The cost of labor in making joints in this manner, so far as it could be determined, was almost exactly double the cost of making plain mortar joints. It is usually very difficult to determine this cost correctly, because the contractor considers joint making one of the minor operations which does not require much care or system, and it is left to a "skilled" laborer or the inspector to manage the operation.—Engineering News.

Color Varieties in Brick

ONE of an observing mind cannot have failed to notice the increasing beauty and diversity of that once rather monotonous object, the brick house. There has been a veritable blossoming of color within the past few years. In order to understand how this has come about it is necessary to have a few facts on the subject of clays in their relation to brickmaking, says C. C. Johnston in Clay Products.

Generally speaking, a brick is light or dark according to the amount of iron in the virgin clay. We might have houses made of almost pure white bricks except for the expense. Clays in which the quantity of iron is only a few hundredths of one per cent are needed for the more refined industry of chinaware, as it is popularly known. The buff-burning clays are those which are low in iron, but still have enaugh to spoil them for the purpose named. It is from these that we get all of our light shades of brick. They would not yield much color variety but for the ingenuity of the brickmaker.

By adding to the clay a certain mineral substance of an iron nature he changes what otherwise would have been a buff into a beautiful grays with which we are familiar. Again, he can adulterate with red-burning clay and run a whole range of buffs until he reaches terra cotta. Changing his tack, he may so manipulate the drafts of the kiln in burning as to force carbon from the coal into the face of the bricks, and secure novel and attractive effects, from buff to chocolate, and even gun-metal. A further expedient is to mix grains of iron with the clay. The grains fuse when the brick is fired, producing the speckled brick which we now see so frequently. Iron in the granular state forms part of the original body of some clays. The effect upon color, whether the particles are natural or are added as an ingredient, is not that of a pigment in the true sense. The iron influence proper exists in every atom of the clay and gives a uniform color to the brick throughout.

One manufacturer makes a feature of a combination for which a bough of autumn leaves was actually used as a model, both for colors and natural blendings. At the other extreme are houses which are purposely given an aged, sober appearance. In its appeal the new brick is similar to that of the half-tone engraving.

With the rough-face brick, as with the smooth brick, those of light color are made of fire-clay, a substance mined in the form of rock at a considerable depth from the surface. But for the more pronounced colors, in the case of the rough-face brick, shales and even ordinary surface clays are freely used. Some of the very impurities of the baser clays are found to be rich in color. What would be a blemish to a smooth brick adds to the unconventional beauty of the rough-face brick. In a single brick unit there is often a mingling of various colors, the reds and browns being shaded into purple or green, with suggestions of gold. General color uniformity, however, can be preserved at will by the nature of the material employed and the sorting of the brick as it comes from the kiln.

Constructional Features of the C.P.R. Banff Springs Hotel

Staff Article

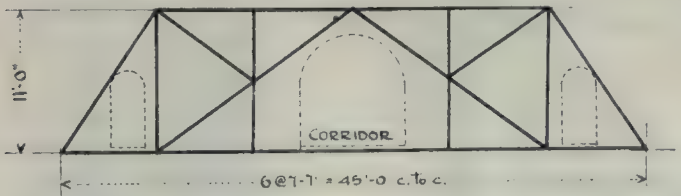
CONSTRUCTION has been completed on the large reinforced concrete addition to the Canadian Pacific Railway Hotel, at Banff, in the Rocky Mountains, largely increasing the capacity and the conveniences of this already popular resort. This hotel is now one of the largest of the C. P. R. hotel system, and contains almost 400 guest rooms, with all the necessary mechanical equipment and other facilities for such an establishment, including, besides power plant and heating system, a laundry and a large self-contained open air swimming pool. The situation of the group of buildings is almost ideal, being at an elevation of 4,500 feet above sea level, on a slight rise in the valley of the Bow River, which at this point makes a right turn, with a small falls, before being joined by the Spray River below the hotel. The main hotel structure occupies the lower extremity of this rise, parallel to its length, and has a maximum length of 550 feet, with a principal depth of 200 feet, exclusive of the swimming pool, and a maximum height of 175 feet above the main footings. In addition, there are minor structures, including the boiler house and servants' quarters, besides small out-houses. The original building was entirely of timber, and additions of the same construction have been made from time to time, the most important consisting of two terminal towers, one of five storeys, the other of six storeys, completed in the spring of 1911. The construction of the concrete swimming pool was then commenced and upon its completion work was started upon the larger reinforced concrete addition, together with the detached servants' quarters. Aside from the interest attached to the completed structures, the work has an addiional interest due to conditions incidental to the isolated situation—two miles from the nearest tracks, with a rise of 300 feet above—besides the necessity of carrying on construction during the time the hotel was in use by the guests, without interference, and also during the severe winter weather prevalent in the Rockies.

C. P. R. Banff Springs Hotel.

The recently completed addition consists of a tower, 200 feet long by 80 feet wide, and 134 feet high from the footing to the main ridge of the roof, with a steep peak rising another 30 feet high. At the base of the tower there is a three-storey wing having a total length of 260 feet and a width of 72 feet, containing the dining room, kitchen, and service. Except for the entrance lobby and hallways, the entire structure is devoted to guest rooms, there being a total of 215 rooms, with 73 private baths, the whole having approximately 135,000 square feet of floor area.

The entire construction is of concrete, with the exception of the terra cotta partitions, the building serving as a fire-wall to divide it into two distinct parts, so that a complete demolition of this hotel, as happened recently at St. Andrews-by-the-Sea, is well nigh impossible. The public spaces are tastefully finished in rough cement plaster effects, with B. C. fir stained a deep brown, fir trim, and red quarry tile floors. The bed rooms and corridors have cement finished floors with carpets, and fir trim. All the bathrooms have Keene cement wainscotting. Some idea of the size of the building may be gained from the fact that there are 150,000 sq. ft. of partitions, 6,300 sq. yds. Welsh quarry tile floors, 300,000 sq. ft. of plaster, and 20,000 sq. ft. of Keene cement in the structure, besides 143 room telephones, and 1,145 electric light outlets. Two passenger elevators, together with one freight and one service elevator, and one dumb waiter, all of the hydraulic plunger type, have been installed.

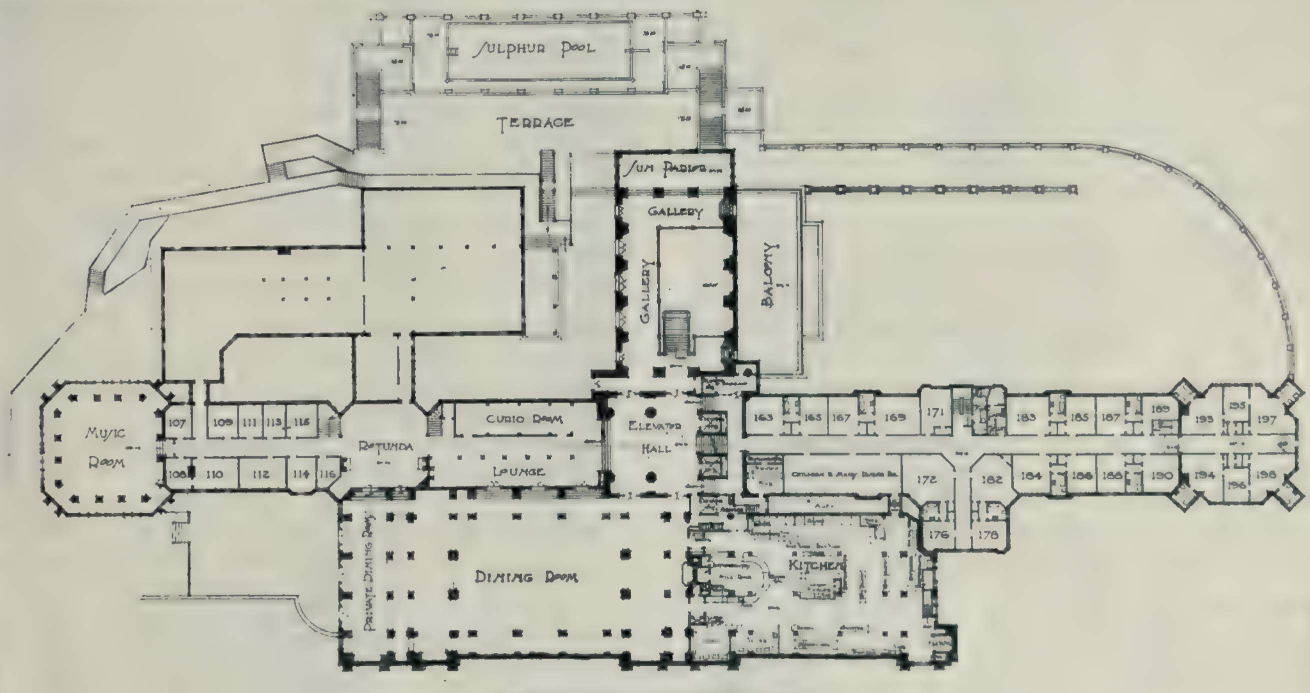
With the exception of certain steel trusses and plate girders, the building is entirely of reinforced concrete. The exterior walls are of blue limestone, laid dry, and backed with concrete. The stone was quarried close to the hotel. The blocks were readily split, and in the walls the stretcher bond, with deep raked joints, combined with the smooth surfaces of the concrete details, is very effective. The architecture may be traced to certain of the French Chateau style, the smooth walls, being unbroken by projecting details, and the sheer roofs pierced with dormers. On the ground floor there is a large entrance hall, 48 feet wide by 80 feet long, and 23 feet 6 inches high, with no interior columns, the floor area above being carried to four steel trusses, 45 ft. 6 in. centre to centre of bearings. The trusses are masked in thick partitions, with doors cut through at each end and an 8-ft. corridor in the centre. In order to allow for the corridor at the centre of the span, it was found necessary to modify the usual type of latticed truss so that there would be no members in the lower half of the two middle panels. This has been accomplished by running the diagonals in these panels through into the next panels, thus:



The gauge lines of the top and bottom chords are 11 ft. apart, the chord sections being built up of four 6-in. by 4-in. angles and two 20-in. plates. The main dining room is 150 feet long by 75 feet wide, lighted by four large ridge skylights overhead. These skylights are carried by four plate girders having clear spans of 51 ft. 6 in., the two inner girders having 30-in. webs, with flanges of 6-in. by 6-in. angles and 15-in. cover plates. The framing of the dormer openings in the steep pitched roof slopes presented something of a problem in the forms for the concrete, but otherwise the design of the superstructure was reasonably simple. With the exception of these features, the construction is of the beam and girder type, with solid floor slabs, and hooped columns. Practically all of the reinforcing steel was supplied by the Trussed Concrete Steel Company of Canada, Limited.

The work of tearing down the central portion of the old wooden building was commenced late in the fall of 1911, and blasting and excavation were continued throughout the winter. The excavation in the main was solid rock, a laminated trap very difficult of removal forming the major portion. The entrance to the new hotel was to be from the east, so the construction was carried out almost entirely from the west side. Due to the slope of the ground on this side, there was some difficulty in storing materials. Two hoist towers, with carpenter shop and concrete plant, besides the stone-cutting yard, were established on the main axis of the tower, abutting the dining room wing, and practically all concrete and other materials were handled from this point. Concrete materials were dumped at the mixers on stock piles, whence they were hoisted 20 feet to the mixer platforms in an Insley stone boat. Concrete was mixed in a ½-yd. Ransome mixer, with interchangeable gasoline and electric motor drive, discharging into an Insley combination bucket and skip elevator dumping into a 40 cu. ft. Insley hopper. The concrete was conveyed to the forms in Ransome concrete carts. Two Marsh-Henthorn hoisting engines were used—one of 20 h.p., handling a 5-ton American stiff leg derrick and an elevator for materials, and the other of 18 h.p. for hoisting the concrete and for a 2-ton Insley portable boom derrick. Forms were built in a shop, where there were installed two C. H. & E. portable saw rigs, electrically-driven, and a gasoline-driven band saw rig. Gravel was at times shipped in from near Calgary, but the uncertainty of deliveries warranted the establishment of a gravel plant on the Bow River, some seven miles below the hotel. River gravel from a bar was loaded into two-wheel carts and hauled a quarter of a mile to bins on a spur track. Six men loaded from the bar into the carts—six carts, with three drivers, averaging 75 yards a ten-hour day. The carts were dumped into a 27 cu. ft. Insley bucket, which was hoisted to the top of the bins by a 12 h.p. engine, and dumped. The hopper bins had a capacity of 150 cu. yds. and loaded direct into cars through quadrant gates. All of the materials entering into the construction were hauled two miles from the sidings at Banff Station, ordinary box wagons and teams being used by the Brewster Transfer Company, who had the contract for hauling. As there were over 8,350 cu. yds. of concrete, nearly 150,000 terra cotta partition tiles, and almost 300,000 sq. ft. of plaster, placed in the building, with other materials in proportion, this alone was a considerable task.

The total cost of this building was about $1,500,000. The entire design and construction was carried out by Mr. W. S. Painter, formerly C. P. R. architect, and later of Messrs. Painter & Swales, Montreal and Vancouver.



First floor plan, Banff Springs Hotel.

Reinforced Concrete in Theory and Practice*

By Alexander Melville, C.E.

PLAIN concrete is a most excellent material in many ways, and ideal, for instance, for such structures as engine foundations, where weight is essential, but it has a serious deficiency in its inability to resist anything but the lowest tensile stress. Also such tensile strength as it has is easily destroyed by vibration.

By the employment of steel to take the tensile stress, we get a fabric at the same time low in cost and applicable to structures, in which plain concrete would not have been used.

How varied are its uses you will find by looking over the advertisements of any periodical dealing with reinforced concrete. There you will find it is employed in almost any type of structure—even boats, incinerators, and tombstones. But one must not take advertisements too seriously. I speak from personal experience. Many things to which it is applied are, I presume, by way of experiment, and one must recognize that by experiment to a very great extent the boundaries of its uses may be extended. But it is unfortunate that experimental uses should be put on the market and advertised as the soundest methods of construction for certain needs. By allowing their enthusiasm to run away with clear judgment, certain advertisers have advocated the building of classes of structures which have proved failures, and have done reinforced concrete decided harm. Whatever is may be used for in the future, at the present state of knowledge of design it has limitations, and is not a universal salve for all structural ailments. It has often been advocated for things which proved unsuitable, uneconomical, and faddish.

One must not forget, of course, that applications which appeared wrong a number of years ago have, as a result of experiment, consequent better design, and improved methods of working, now been accepted as right, and are established.

I think there is too much talk about "systems." It makes for confusion in the mind of one who does not understand the principles underlying all designs. There are a great many who claim a new system and take out a patent by virtue of cranking a bar in some new place; but perhaps this is only natural in the rush to sell at the beginning of the demand.

Unfortunately, the older civil engineers were disinclined to take up seriously a method of construction apparently, possibly because for the purpose of design Molesworth was useless. But as reinforced concrete was a fabric of undoubted value, a new branch of the profession was of necessity created.

I cannot but think that not a few specialists make a difference in the placing and the cranking of bars and the form of stirrups, deliberately for the purpose of being able to talk about a "system." I believe that gradually so-called systems will disappear, and work will be carried out to the designs of engineers as it was before the days of reinforced concrete.

Before this comes about, however, I am afraid we will have to listen to the advantages of the various systems from their biassed advocates for many years. In listening to them, I would advise you never to allow yourself to be impressed at the time, but to consider everything coolly and alone next day. I find this a most excellent principle to follow. If there is something you are not quite clear about ask the representative to call again. He will run to you. Generally speaking, you will be on safe ground if you clear him out as soon as he has answered your queries.

In starting to consider any of their designs remember that it does not matter what the particular system is or whether it has a name in hieroglyphics; there is nothing mysterious about it except possibly the special advantages claimed.

The same principles underlie, or should underlie, all designs. Indeed, the most difficult problem is one which engineers and architects have studied, and without the use of a book on reinforced concrete, namely, the determination of the stresses in a member of a structure. When comparing various designs for the same structure one finds, as in dealing with any other structural material, that there is every possible degree of goodness or badness, and in this lies the most of the difference between the various systems as carried out.

The various so-called systems are legion. I have not time to explain their individual advantages or discuss the claims that are made for them, or even describe their particular fads. Some I dare not describe, as I would be apt to confuse them. Nor would I recommend that you should or should not adopt Hennebique system because of the smithed ends to their bars or because of their type of stirrups; or Considere, for their spirals and hooks; Coignet, for their method of dealing with shear; or Kahn and the Indented Bar Company, because their bars are something original and expensive. Nor will I condemn or praise those who employ a particular form of mesh, such as Clinton, Johnstone wire lattice, or triangle mesh. There is nothing wrong with any well-known system, because there is nothing wrong fundamentally with the combination of steel and concrete. However, you have only to listen to the representatives of the various systems to find out that there is something to be said for every one, even those that could never be put into practice.

---

*Abstract of a lecture at the Northern Polytechnic Institute, London, Eng.

There are uses for them all. Even the system which claims to reinforce metal may be used with complete safety if one has plenty of money to spend.

Novel Reinforcing Material

I know a builder who undertook to erect a small single-storey building in reinforced concrete without the help of a specialist. When the walls were half up he proudly asked me to inspect his work. To my astonishment, I found an extraordinary disposition of bars appearing out of the concrete. They were twisted in all fashions and braised at junctions without any apparent reason.

Gradually I understood, and could not restrain my laughter, but I did not offend the builder. "Yes," he said, "so far the walls are built entirely with ends and other scraps of bedsteads." I may say he disdained patenting his system, and yet that building has been standing for a number of years. I do not know that I could unreservedly recommend this bedstead system, but yet it has its use, and it must have been a very economical design.

What one ought to do in comparing competition designs is never to think of a system at all, but look for good design, and remember that all designs we look at are, or ought to be, based on the same fundamental principles.

Another thing one should do is to find the amount of steel and concrete employed by each designer, and if you find one which is considerably different, look into his design most carefully, for it stands to reason that in well-designed work, if the same loading and factor of safety be taken, there can be very little variation in the quantities of these materials. It is advisable, also, to see that the quantities given are approximately those that go into the work of the successful tenderer.

There is a type of construction which I find some are apt to place under the heading of reinforced concrete, but a little consideration would show it is something quite different. I refer to the fireproofing of steel structures by encasing in concrete or fireclay blocks and slabs. These blocks and slabs are not intended to be stressed, but are used merely as a protection of steelwork against damage by fire.

I pointed out earlier, that structures had been erected in reinforced concrete which were not suitable for its use in the present state of knowledge. I would like to name now a few structures to which it is admirably adapted if well designed and well constructed.

Advantages of Reinforced Concrete

First of all, a word as to its advantages. It forms a monolithic structure, and thus makes a much sounder building than the old disjointed method of building steelwork loosely into stone or brickwork. It is fireproof in varying degrees, depending on the aggregate used in the concrete and the cover of the steel. It is economical both in first cost and in maintenance. In such structures where steelwork is exposed the cost of frequent painting is saved.

If properly imbedded in the concrete, the steel will not corrode under water. A consideration on expensive sites, also, is the possible saving of room in the thickness of the walls.

For bridge work, reinforced concrete is admirably adapted. It is economical, particularly in upkeep. In a few cases but that of a high viaduct over a river, with much traffic, is the erection expensive.

Again, I think it is much more capable of architectural treatment than a steel structure. It is a highly suitable material for piles and for jetties generally. There is no corrosion of the steel and no rotting, as in timber. Toredos find it indigestible. It is also highly suitable for retaining walls and for tanks, in both cases being economical and saving considerable room compared with stonework. In tanks, also, there is not the maintenance that is chargeable to steel. It is being used with increasing frequency and is thoroughly satisfactory for such structures as silos.

In floors, columns, and girders, in factory and public buildings, it is also employed satisfactorily, but I do not know that it is to be recommended for walls in the majority of buildings. Walls can be made thoroughly sound and very much thinner than is the case with the older methods, but I am afraid that the architect with a reputation for a good elevation (and this is the only part of a building that later generations consider) will wish something more than strength. For factory walls it is all right if there is no intention of future extension. But if there is, and openings for doors, etc., are to be cut or the face of the building taken down for the purpose of joining, I am afraid one would be faced with a tricky problem. It would be almost necessary, also, to employ the same experts for the extension, as an accurate knowledge of the position of the reinforcement and the original method of design would be essential for safe working. It would also be necessary to employ him so that responsibility for any damage to the old building could be fixed.

We will find the most popular type of public building in the future will be a reinforced concrete framed structure, with reinforced concrete floors and stone or brick thin walls.

For raft foundation work, reinforced concrete is invaluable, even although it is impossible to do more than guess the external forces acting on it. (Competitive designs for a raft would be excellent in indicating who are our bold engineers and who are our timid.)

When an architect has a structure in reinforced concrete to carry out, he employs, either through choice or competition, a specialist, and says, "Look here, your representative is the most superb talker I have come across. I want you to design some work for me." They look pleased, and give him quantities and drawings, which he submits to all contractors in sundry, or a few of impeachable character, and the contract is fixed as the result of a competition in price only.

In the second case he deals immediately with the contractors, and the contractors send the inquiry to their pet specialist or to the specialist to whom they have tied themselves under money penalty. In this case the contract is fixed as the result of a competition in price and design. But in this case design is merely a question of quantities, as no specialist does, or has time to, make complete drawings for the job in the short time at his disposal before it is tendered for.

Thus it looks as if the first method would assure the best job being made. There is, however, another point to consider. By dealing with the contractor you have only one man to deal with, but by adapting the first method you are at one corner of a triangle, and if anything goes wrong with the work, you rather wish you were at the end of a straight line leading direct to one on whom you could fix responsibility.

This, however, is not a point to be much afraid of if one is careful to select a thoroughly capable firm of specialists to design the work, and, what is quite as important, to allow only those contractors to tender whose workmanship is beyond suspicion, and who have a thorough understanding of the importance of keeping strictly to the working drawings, although they may show in certain places very awkward pieces of construction.

Do not, on any account, allow plasterers or others whose knowledge of concrete work is based on the putting in of concrete foundations specified at six to one, executed at ten to one. If it is their first tender for reinforced concrete work their prices will be alluringly low, and if there is a good clerk of works on the contract they will have to be a firm of substantial standing to withstand the monetary loss. Another very important factor is the employment of a thoroughly good clerk of works; not an habitual growler, or one who spends all his time making test cubes, but a man who really understands the class of work. A good clerk of works is a blessing to a job and to the contractor. He will not keep work back, but will do his best to help a contractor to get ahead quickly. He will be decided as to his reading of the specification, and he will stand no attempt at scamping or inferior workmanship. His advice will be given freely as to the scheme of operations, and it is often invaluable, as he has had experience of the methods of work of various contractors, and is in a position, if he be an intelligent man, to compare them and see clearly what are the best.

(Concluded in next issue.)

The Use of Marble in Architecture

DURING the last twenty years marble has been employed more and more in architecture, but in America it has for years been used not merely for interior decoration but for entire fronts and even construction, notes a writer in The Stone Trades Journal. Public buildings, banks and insurance offices are fronted with white imported Carrara marble, and yet the effect is not altogether what one would expect. The influence of the weather soon asserts itself and the marble becomes yellow, until finally its appearance is not much different from that of the considerably cheaper sandstone. On the Continent, too, marble is being used for external decoration, but not to any appreciable extent compared with inside decoration, where both white and coloured marbles are lavishly employed. This applies especially to hotels, restaurants, banks, etc., and also to the halls and staircases of mansions and homes of the wealthy. But any definite artistic principle as a whole seems to be sadly lacking; frequently streaked and variegated marbles are used for sculpture, for floral and mural designs. The immediate effect is that there is something distinctly out of place, and Continental architects do not yet seem to have recognized fully that veined and coloured marbles are best reserved for large surfaces, pillars, etc., and that a high and glass like polish is absolutely essential to the right effect.

Apart from constructional work, marble is beginning to be largely used in interior decoration, principally in businesses where there is a large amount of wear and tear, and where absolute cleanliness is essential. Mention must also be made of the increasingly elaborate lavatory fittings; they too have opened up a large and important field to marble, and the same may be said of the large hotel and restaurant kitchens as well as the hospitals. The utility of marble for electric switchboards and furnishing purposes is well known, although only of secondary importance to the subject of our article.

The use of marble for interior decoration dates back to early times and undoubtedly began with the ancient Romans, according to some authorities after the Egyptian conquest, according to others much earlier. Be that as it may, it is certain that the use of costly marbles came into fashion during the latter decades of the Roman Republic and that the stone was imported and considered a great foreign luxury, far too costly for general use. After the downfall of the Roman Empire, and the capture of Constantinople by the Turks, marble sank back into oblivion for centuries, not to emerge again until the awakening following the dark ages. From the 12th century on, Spain, Italy, France, Germany and the Low Countries employed it extensively in ecclesiastical architecture and gradually it became more general on the entire continent until the outbreak of the French Revolution called a halt at the zenith of its popularity. Then marble fell into disuse once more, to remain so for many years; but it is to be hoped that there are signs of a restoration to the place it has rightfully held for centuries.

In interior decoration the architect has a scope for working on either a combination or a contrast of colour which is sometimes not properly appreciated. True it is no easy task to suit the delicate, softening, effect of marble to the high glaze and density of colour of tiles and other artificial products. Marble absorbs and retains the light whereas the impenetrable polish of artificial stone hurls it back with a vengeance, making the marble appear insignificant. Happily these contrasts are noticeable only in large surfaces; in smaller ones even quite artistic combinations are possible between natural stone and the work of man. Ancient Roman mosaic floorings are the best proof of this. This combination is also possible for mural decoration and instead of presenting a vast unbroken expanse that can only tire the eye, be it now marble or any other material, a wall could well be relieved by ornamental pilasters and friezes, giving the artist room for display of taste and fancy.

It need perhaps hardly be mentioned that the great architects of old employed coloured marble as well as jasper, agate, and lapislazuli whenever it was obtainable. Sometimes it was a column that was fashioned from it, sometimes a wall or dado, a vase or a bowl. If the design of the stone showed up prominently it was used for large surfaces, but as soon as there was any tendency of monotony the stone was divided into small pieces. Frequently a large slab, richly veined and streaked was framed in a border of multi-coloured mosaic—especially in Moorish and Venetian art. Sometimes, in the case of rich and many coloured porphyry and marble a narrow band of less conspicuous marble first surraunded the slab, and then came the actual masaic frame. This consisted of either cubes, stripes or chips of fine marble, majolica, glass, or mother-of-pearl. These many examples of ancient taste show what can be accomplished even with infinitesimal fragments of the most varied materials, such as enamel, glass and gold in addition to those already mentioned.

There was a time when the interiors of most hotels and restaurants were panelled in wood four to six feet high, and only when this panelling began to be carried right up to the ceiling did the re-action in favour of stone set in. The normal is obvious, and should remain a warning not to overdo the matter of large surfaces without any relief.

If in the past too much importance has been attached to the uniformity of material, the reverse may almost be maintained at the present. It is indeed not uncommon to see pillars, front, door and window frames each in stone of different colour and design with apparent complete disregard of the fact that some of the veinings completely overshadow others. A little more harmony would conduce greatly to a better effect and the stone should be chosen with a little more consideration for its purpose. It can well be done without detracting from the artistic appearance of the whole.

For sculptural work a plain unmarked stone is the only right one and whilst in straight columns veins and markings do not matter, they detract immensely from the appearance of a capital. Here, like in sculptural work, light and shade play an important part and if a variegated stone is used it is often unavoidable that places which should show the highest of high lights are marred by some prominent marking or another, whereas parts intended to be shaded, show up stark white.

In these circumstances, Nature's work will never harmonize with that of the sculptor and, on the other hand, no matter how beautiful the marking and veining of a stone, it is absolutely wasted if not given due prominence.

It is much to be desired that architects and designers should familiarize themselves with marble and its literature, for frequently, when the contractor designates a certain stone as unfit for any particular work, it is thought that he has merely an axe to grind. And then when the work is unsatisfactory the marble is blamed.

Only too often do architect and builder alike expect impossibilities from marble. It is rare to obtain variegated marble without cracks and flaws and even to get the same coloured slabs from one and the same block is a matter of luck. The main question is whether the marble is intended for interior or exterior use. If for the latter no matter which kind is chosen its weathering qualities should be beyond dispute, for nothing discredits any kind of stone more than a rapidly decaying facade or decoration.

Summing up, it can be said that the use of marble, both uncoloured and variegated, for architecture as well as decoration is increasing; yet marble deserves to be even more generally used, for there is no other material that gives the architect the same facilities for design. The evenness of surface, the quiet blending of colours, that can be arranged render it unapproachable as a means of artistic expression and real decorative effect. Its number of qualities and different colours are legion and, while imitations abound, the real article more than holds its own, and no artificial product can seriously challenge comparison with that from Nature's workshop.

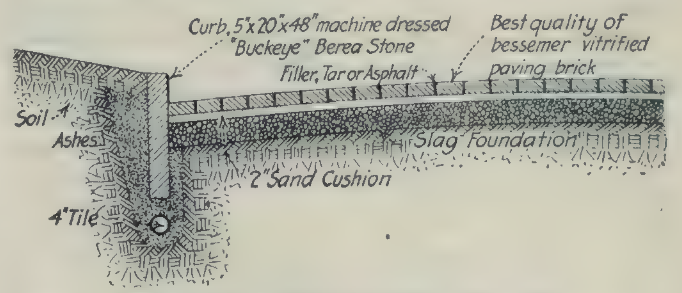
Coal tar is now used as a fuel in steel furnaces at Gary, Ind. It is first heated to liquid form, then sprayed into the furnaces, mixed with blasts of air under pressure. A somewhat similar use of coal dust has been made as an experiment. The dust is fed to the furnaces in a continuous stream, mixed with air under pressure. The success of this plan has been so great as to raise the question whether it would not be economical to crush and grind all the coal used in large manufacturing plants. The dust burns with an intense heat. There is no smoke, because the combustion is perfect.

The Economics of Brick Pavements

Cost of construction and cost of repair and all else is not the full measure of the economy of a road surface. The greatest element affecting the economy of any road is its out of repair condition. That road which calls for the most frequent repairs is the road that is most likely to be out of repair, and it is the road that in the sum of lapses of time in which it is out of repair, aggregates a total detraction from the road's worth which by the lesser load hauled, the broken spring, the injured horse, the extra wear and tear of the vehicle, if converted into dollars, would often equal in a short period of time, the entire original cost of the road improvement.

When a road is out of repair, the road investment is yielding no return. The road as a whole is only as good as its worst portion, even the rule of averages will not apply. On the other hand, by inverse ratio, the road approaches its maximum worth as repairs are eliminated.

The original cost of a brick road is not necessarily excessive. The cost of grading, drainage, bridging and the entire preparation for placing the foundation and wearing surface, should be alike for all types and is therefore no more expensive for a brick road than is required for the least expensive type of wearing surface. These preliminary structures are not readily injured, either from wear or tear or from any character of climatic influences. The foundation is likely to remain intact. With the brick wearing surface placed upon it, ample protection for the durability of all the work incident to such preparation is afforded.


Curb, 5"x20"x48" machine dressed "Buckeye" Berea Stone
Best quality of bessemer vitrified paving brick
Filler, Tar or Asphalt
Soil
Ashes
Slag Foundation
2" Sand Cushion
4" Tile

Brick pavement with slag foundation, Niles, Ohio.

Specifications for Slag Foundation for Brick Pavements

Slag, under proper methods of construction, is an excellent foundation material for paving streets and is the nearest approach to concrete obtainable, according to Harvey F. Brown, Engineer of the Borough of Charleroi, Penn., writing in the Engineering News. The use of slag means a saving over concrete foundation of approximately thirty cents a square yard—this in the iron and steel districts where slag is readily obtainable. Our contemporary learns from Wm. V. Alford, City Engineer of Niles, Ohio, that slag has been used with much success under brick pavements in that state and gives the following specifications for this foundation:

(1) Specifications for grading, rolling and crowning the earth foundation, or subgrade are to be the same as for concrete foundation.

(2) **Slag Foundation**—There shall be placed on the subgrade 6½ to 7 in. of air-cooled, blast-furnace slag, from the Carnegie Steel Company, of Youngstown, Ohio, or slag of the same specific gravity. This shall be the crusher-run slag

not larger than 3 in. in any dimension. It shall be evenly distributed over the subgrade. This can best be done by the use of wooden blocks, as directed by the engineer. When thus levelled the slag shall be rolled until there is no appreciable settlement. While thus rolling careful examination of low places in the foundation must be searched for and when found the slag must be loosened with a pick and rerolled with sufficient added material to bring the low spot to an even grade and surface level and of the same density as the rest of the foundation.

(3) The slag foundation shall be rolled with a 10-ton steam-roller, weighted if directed by the engineer. The rolling shall begin at the curb and work toward the crown, the spacing of the rolled portions to be as directed by the engineer. The rolling shall progress toward the center until the entire foundation has been keyed in at the crown, and all interstices have been reduced to a minimum, in the judgment of the engineer, and all low places corrected.

(4) **Slag Sand**—Slag sand shall be placed on the foundation and worked into all voids by sweeping with a steel or rattan broom. The sand must be evenly distributed over the slag foundation with shovels, from convenient sand piles placed on the burm of the roadbed. After each passage of the roller the sand must be thoroughly "hetcheled" with a stiff brush as above noted. This process shall continue until there is a smooth, hard and convex surface, acceptable to the engineer.

Water shall be applied by sprinkling as directed during the last half of the rolling in of the sand. It shall continue until a grout is formed with the slag, sand and water, which must wave slightly before the roller.

The foundation is now ready for the cushion of sand. This sand cushion shall be placed as noted in the specifications for concrete foundation.

At the invitation of Mr. H. C. Harding, a number of architects and contractors, on June 9th left Montreal in a special train to inspect the plant of the National Builders' Supply and Enamel Concrete Brick Company, Limited, at Mascouche, P.Q. Mr. Harding explained the process of manufacture, pointing out the advantages of the brick, and briefly sketching the history of the company. It was, he stated, a new industry for Canada, the capital for which had been found in Europe. Concrete bricks, he predicted, would eventually take a leading part in structural materials in Canada, and architects were invited to investigate the claims made by the company. It was intended to develop the industry throughout Canada, and sufficient business had been secured to warrant ordering another machine to be erected at Mascouche. After luncheon several visitors spoke, wishing success to the enterprise.

It is with much regret that we have to record the death of Mr. Robert H. Skelton, of Mimico, Ont., manager of the Ontario Sewer Pipe Company, Limited, since January, 1909. The late Mr. Skelton was born at Drayton, Ont., 44 years ago and entered the service of the Grand Trunk Railway at an early age, remaining with them many years, in fact until he became identified with the Ontario Sewer Pipe Company. He was the first Reeve of Mimico and rendered the municipality excellent service in this capacity. His death—from cerebral hemorrhage—came as a great shock to his friends and business associates. Apparently he had been in the best of health. He was stricken down suddenly on the way home from his office on Wednesday, June 10.

Mr. James L. Taylor, road superintendent for the county of Wentworth, Ont., has accepted a similar position at Parry Sound.

Personal Mention

Mr. Hugh McDougall, contractor for the new Martin block, now in course of construction at Wallaceburg, Ont., was seriously injured by falling from the second storey of the building a few days ago.

Mr. J. H. McMichael, of Chicago, the inventor of the Pneumatic Concrete Mixer, has been on a visit to Montreal. Later he will probably reside in that city with a view to superintending the work of the Pneumatic Concrete Placing Company of Canada.

Mr. J. P. Case has been appointed Canadian representative for the Brown Hoisting Company, succeeding Mr. F. A. Peck, who has resigned. Mr. Case has been identified with the Brown Company for many years and is entirely conversant with all Brown hoist products. He will spend all his time in Canada and will be assisted in his work in this territory by Mr. Hoyt E. Hayes.

The Retiring City Engineer of Winnipeg

Lt-Col. Henry Norlande Ruttan, who has resigned the city engineership of Winnipeg after a continuous service of nearly thirty years, was born at Cobourg, Ont., in 1848. Prior to his connection with the City of Winnipeg he had extended experience both as an engineer and as a contractor on the construction of the Intercolonial and Canadian Pacific Railways. He has had a distinguished military career and possesses in addition to the Long Service Decoration medals for service in the Fenian Raid and the Northwest Rebellion. He was a member of the first Council of the Canadian Society of Civil Engineers in 1887 and was President of the Society in 1910. He will be retained by the city of Winnipeg in the capacity of consulting engineer and will receive a pension, which, combined with his salary, will give him a yearly income of five thousand dollars. Mr. Ruttan is a member of the Council of the Institution of Civil Engineers of Great Britain and of a number of United States bodies.

Lt. Col. Ruttan.

Mr. C. D. McArthur, whose appointment as chief engineer to Messrs. Foley Bros. Welch, Stewart & Fauquier, contractors for the Halifax Ocean terminals, was noted recently in these columns, was for five years chief engineer for the Blaw Steel Construction Company, of Pittsburgh. His first important position was that of engineer on shop construction for the Buffalo & Pittsburgh Railway, from 1900 to 1903. During 1903 he was master mechanic at the Adrian Furnace at Du Bois, Pa. For three years, 1905 to 1908, he was engaged in consulting engineering practice in New York City.

The City Engineer of Edmonton

Mr. A. J. Latornell, City Engineer of Edmonton, the activities of whose department are the subject of an article in this issue, was appointed Acting City Engineer of Edmonton in 1908 and succeeded to his present position in February, 1910. Mr. Latornell was born at Meaford, Ont., and is of French Huguenot descent. He began his engineering training in the autumn of 1898 by entering the shops of the W. A. Johnson Electric Company, of Toronto, as special apprentice. After serving in these shops and those of the United Electric Company of Toronto, he entered the School of Practical Science in October, 1900, graduating in May, 1903, with honors in Civil Engineering. His vacations were spent in survey work in the West. In May, 1903, he entered the services of the Canadian Pacific Railway as assistant to the resident engineer on maintenance of way at Ottawa, Ont. In June, 1904, he made connections with the Public Works Department of the Northwest Territories, in whose employ he continued until October, 1905, when he returned to the University of Toronto to take up post-graduate work in civil engineering. In May, 1906, he graduated with the degree of Bachelor of Applied Science. After graduating he was employed by the Iroquois Construction Company of Lockport, N.Y., and was engaged on transmission line work for the Ontario Power Company. In July of the same year he resigned to enter the service of the city of Edmonton.

Mr. A. J. Latornell.

Mr. G. A. McCarthy has been appointed engineer of railways and bridges for the department of works, Toronto, in succession to Mr. C. W. Power, who resigned recently to take up a position with the Canadian Stewart Company on the Toronto Harbor work. Mr. McCarthy graduated from McGill University; for seven years was in the engineering department of the Intercolonial Railway; was engineer of the C. P. R.; chief engineer for Algoma Central R. R. and chief engineer on Canadian power development work at Niagara Falls. From 1905 to 1909 he was chief engineer of the T. N. O., and from 1909 to 1912 was with a Toronto firm of engineers. Last year he was resident engineer on hydro work at Feather River, California.

Mr. Geo. E. Turner, Building Commissioner at Edmonton, Alta., since 1909, has resigned, his resignation to take effect on June 30. The School Board has decided to engage Mr. Turner during July, August and September as consulting architect.

Building Progress at Montreal

A new theatre will be erected on St. Catherine Street West, while several picture houses are in course of erection, one of which on St. Denis street, will mean the expenditure of $300,000. The National A. A. A. propose to build a new club house on Cherrier street, to cost $175,000; Turgeon and Ouellette are the architects.

There will be several additions to the list of apartment houses. The largest of these is one for which plans have been prepared by Audet and Charbonneau; it is a $275,000 house on St. Catherine street, Westmount. A considerable portion of the Northern Electric factory at Point St. Charles has been completed, this being the largest structure of its kind ever erected in Canada. The cost will be over $2,000,000. Work is in progress on the Ford Motor factory, which will cost $100,000, and about the same amount is to be expended in the building of a Tuckett tobacco factory. The contract is about to be awarded for an addition to the Alexandra Hospital, to cost $100,000, while the Royal Victoria and General Hospitals are also making additions to their buildings.

The most important ecclesiastical work is the new St. George's Church, Dorchester Street West, tenders for which have been called by Messrs. Barott, Blackader & Webster, the architects. It will be a very fine building, with a magnificent interior. The foundations of a church on Fullum street are completed; the cost of the building is estimated at $150,000, the architects being Beaugrand-Champagne & Chenevert. The same architects have made plans for St. Michael's Church, St. Urbain street, the cost of which will be $250,000. A synagogue is to be erected on St. Urbain street at a cost of $90,000, Mr. C. Dufort having drawn the plans. A large church will be constructed on Delorimier avenue; Mr. Marchand and Mr. Venne are the joint architects. Several new schools are in course of erection or are planned, Nobbs and Hyde having the principal designs in hand. Doucet & Morrissette and Mr. Marchand are joint architects for a large girls school on Demontigny street, the estimated cost being about $40,000. Fresh tenders have been asked for Loyola College, estimated to cost $400,000.

As compared with the last two or three years, there are few important buildings in course of erection or projected in Montreal. Probably the one involving most money is the new customs house warehouse, the foundations of which gave unexpected trouble, and which resulted in the Foundation Company being called in. A large part of the steel work is now up. The Sun Life Company's building on Dominion Square is also making considerable progress. The Bank of Toronto is rebuilding its branch, but the work has only just commenced. In addition to the bank premises there will be a large number of offices, the contract being let to the Atlas Construction Company. Tenders are in for a new office building on Dorchester street, to cost $175,000, for the Liverpool and London and Globe Insurance Company, from plans by Mr. Rawson Gardiner and Messrs. Nobbs and Hyde. Excavations are being made for an office building for the National Trust Company, on St. James street, estimated to cost $150,000, the architect being Mr. K. G. Rea, and the contractors, the Norcross Brothers Company. The city have decided to build some large stores and a garage at a cost of $120,000 and also to make a start with libraries. The plans for the initial library will be open for competition, the first prize being $1,000, the second $800, and the third $500. The neighboring city of Westmount will construct a new city hall, and here, too, the plans will be open to a competition by architects.

MAINLY CONSTRUCTIONAL

EAST and WEST — FROM COAST to COAST

EASTERN CANADA

J. A. King & Company, Limited, is a new Montreal concern incorporated with a capital of $150,000, to manufacture and deal in fireproofing and building materials.

Plans have been completed for a new registry office building to be erected at Toronto at a cost of $400,000. The architect is Mr. C. S. Cobb, 71 Bay Street, Toronto.

The Welland County Council have awarded to the Standard Crushed Stone Company, Niagara Falls, a contract for thirty-five miles of road work running into $180,000.

A sewerage system, estimated to cost $100,000, is to be installed at Whitby, Ont., and tenders for the work are now being received. The engineer is Mr. T. Aird Murray, of Toronto.

The County of Laval, P.Q., and the municipalities of Longueuil and St. Recollet are extending the work of laying concrete pavement, and the village of St. Rose are starting on similar work.

At Montreal, the erection of a new theatre estimated to cost $200,000 is projected by Maurice Wolff, 150 Peel Street, Montreal. It is expected that a competition for plans will be arranged shortly.

Hon. J. A. Tessier, Minister of Roads for Quebec, has been requested by a deputation of Mayors of the counties of Levis and Lotbiniere to construct a road from Quebec to Montreal on the South Shore.

Defective wiring is thought to have been the cause of a fire which broke out at the Woodbine Avenue sewage disposal plant, Toronto, on June 11, involving $500 damage to the contents and $25 to the building.

A garbage disposal plant at a cost of $720,000 is the latest project of the Toronto Board of Control. The plans are for a central incinerator and reduction plant to be located in the Ashbridge's Bay district.

Mr. Joseph Gosselin, a well-known contractor of Levis, Que., has been awarded the government contract for the construction of the Transcontinental station on the Champlain Market site. The station will cost over $100,000.

Tenders are to be invited shortly by the architects, Messrs. Stewart & Witton, for a 16-room school building at Hamilton, Ont., for which plans are now in progress. The cost of the structure is estimated at $100,000.

Building permits for May in the city of Quebec amounted in value to $461,595. The total for the five months since January 1 is $1,252,114, which is more than double the amount for the corresponding months of last year.

Steel work is in progress on the new customs house which is being erected at Fort William at a cost of $175,000. The general contractor is Mr. M. H. Braden and the contractor for the steel work is the Hamilton Bridge Works Company, Limited.

Foundation work has been completed for a new church estimated to cost $150,000 for the Parish of St. Eusebe de Verceil, Montreal. No tenders are to be called before July 1. The architects are Messrs. Beaugrand, Champagne & Chenevert, 182 St. Catherine Street East, Montreal.

The Polson Iron Works, Toronto, was visited by two serious fires on the morning of June 14, entailing a loss of about $20,000. The first fire, which completely gutted the blacksmith shop, broke out early in the morning, and was the cause of the second blaze, which partially destroyed the machinery shop. The loss in both cases is covered by insurance.

Quebec Government engineers left last week for Lake St. Francis to do the preliminary work in connection with the construction of the great storage dam on the St. Francis River. This dam will raise the water in the lake twenty feet. It is understood that the government has abandoned its work on the St. Maurice River owing to disagreement with the power owners.

Work is in progress on the half-million-dollar post-office now in course of erection at St. John, N.B. The building is to be 200 ft. by 160 ft. in dimensions, two storeys high, of artificial stone construction. The stone work is now up one storey. The architect is Mr. G. E. Fairweather, St. John, and the general contractors are Messrs. Rhodes, Curry & Company, Amherst, N.S.

The John Raper Piano Company, of Ottawa, are carrying out extensive alterations and extensions to their establishment on Sparks street. Included in the alterations which are planned will be the devoting of the main floor of the building and the mezzanine floor to sound-proof demonstration rooms. The work is being carried out under the direction of Mr. George, architect.

The Parliament Buildings, Toronto, was the headquarters last week of a conference, taken part in by representatives from every province in the Dominion, with the exception of Alberta and Prince Edward Island. The object of the conference is to secure uniformity in boiler inspection laws for the whole of Canada, and as such it was of great importance to Ontario boiler manufacturers, whose representatives were present in large numbers.

Extensive operations are involved in a contract which Messrs. Foley Bros. Welch, Stewart & Fauquier have for the Halifax Ocean terminals. This contract includes the construction of quay walls 6,534 ft. long, including 13,000 tons of steel, 275,000 cu. yds. of concrete; 467,000 cu. yds. of excavation and dredging, and 3,000,000 cu. yds. of fill. The contract time allowed for the work is three years, and the contract price is about $5,500,000.

Messrs. Sherwood & Sherwood, general contractors, Sudbury and North Bay, have opened an office at 111 Mail Building, Toronto. They have started work on several contracts received recently from the city for sewers and sidewalks. Operations will start immediately on the Dunkleman warehouse, for which they have the general contract. Contracts for several stations on the Cochrane Division of the T. and N. O. have just been closed. Mr. A. C. Morgan is in charge of the new office.

Plans are practically completed for the erection of a half-million-dollar crucible steel plant at London, Ont., where a ten-acre free factory site is said to have been offered by the Argyle Land Company. The plant will employ about one hundred men at the commencement, and high grade steel tool castings will be manufactured. It is expected that $100,000 bonds will be issued at once, and work commenced on the building this summer. Hamilton and Buffalo capitalists are reported to be interested in the enterprise.

The City Architect of Toronto, Mr. W. W. Pearse, is preparing some amendments to the building by-laws with the object of preventing the erection of any buildings to be used as hotels, no matter what their height may be, unless the specification provides for fireproof construction. Under the existing by-laws unless the proposed building is over 35 feet in height there is no obligation on the part of the builder to render it fireproof. Mr. Pearse announced that it was his intention to protect the travelling public and others in every way possible, and that as far as he could prevent it there would be no firetraps in Toronto.

The new concrete manufacturing plant of the Concrete Builders, Limited, at Gibson, N.B., is said to be one of the busiest industries in that section of the country, notwithstanding that the company was organized and started operations quite recently. An order has been received for 12,000 concrete blocks to be used in the construction of a warehouse, 50 ft. by 80 ft., for the Sumner Company, at Moncton, N.B. Two experts in concrete work, Messrs. H. J. McGrath and T. C. Burpee, C.E., are identified with the management and the company are said to have the only plant of machinery for manufacturing concrete products in the Maritime Provinces.

The Canadian Society of Domestic Sanitary and Heating Engineers closed its convention at Ottawa on June 13 with the election of the following officers: President, G. S. Dorman, Moncton; Vice-President, E. H. Russel, London; Secretary-Treasurer, W. J. Crawford, St. John; Provincial Presidents: Alberta, Joseph Marr, Calgary; Manitoba, A. J. Hammond, Winnipeg; Saskatchewan, N. B. Rowntree, Swift Current; British Columbia, S. A. Wye, Vancouver; New Brunswick, D. J. Shea, Fredericton; Nova Scotia, J. E. Godwin, Halifax; Ontario, F. R. Maxwell, Toronto; Prince Edward Island, B. Shaw, Charlottetown; Quebec, John A. Gordon, Montreal. Next year's convention will be held at St. John, N.B.

Contracts for work involving the expenditure of $230,000 were awarded last week by the Hydro-Electric Power Commission for the dams, canals and penstocks at Eugenia Falls, on the Beaver River, near Owen Sound. Two dams are to be constructed. The contract for No. 1 dam has been awarded to the Ambursen Hydraulic Construction Company of Montreal. This will be one of the largest works of its kind in the Dominion. The dam will be built of reinforced concrete, 2,000 feet long, and with a varying height from 40 to 50 feet. No. 2 dam will be built by Messrs. Hyland, Scribbin & White, of Toronto, and will not be as large as No. 1. Tenders are now being called for the necessary hydraulic and electrical equipment, which will be used to develop 4,000 horse-power, although the headworks, canals and storage reservoir of the undertaking contemplate an ultimate development of 8,000 horse-power.

General business conditions in the Maritime Provinces are in a healthy condition according to a report received from a St. John, N.B., correspondent of the Contract Record. The industrial situation does not show a great deal of activity, but the banks report business satisfactory and real estate values remain firm. In the constructional field the activity in house building is noticeable, building permits issued during May showing an appreciable increase over the same month last year. Many engineering works of considerable magnitude are projected or in progress. At St. John, the harbor development is proceeding vigorously. The new spandrel arch bridge across the Reversing Falls is advancing towards completion. The C. P. R. have had plans prepared for a new steel bridge to be built alongside the new structure and in addition the Dominion Government has undertaken to build two steel railway bridges for the rails of the Valley Railway by which it is expected that the traffic of the G. T. P. will enter St. John. One of these bridges will cross the St. John River and the other the Kennebecasis River.

A new building for the head office of the Bank of British North America was opened a few days ago at St. John, N.B. The site occupied by the new structure is 4,250 square feet and the building has a frontage of 86 feet on Market Square and Dock Street. The construction of the building, which has three storeys and basement, is reinforced concrete, brick and terra cotta. In the basement is a safety deposit vault of drill-proof steel, fitted with triple doors. There are 225 safety boxes, each box requiring three keys to unlock it. The vault was constructed by J. & J. Taylor, of Toronto, and is equipped with time locks and an electric burglar alarm system. In the banking room on the ground floor, terrazzo flooring has been adopted in the public space and arrowlock flooring in the banking space. All the woodwork is of quartered oak and the main staircases of marble. The building is entirely fire-proof. The architects are Messrs. Barrott, Blackader & Webster, of Montreal, Mr. G. E. Fairweather, of St. John, being the associate architect. The general contractors are B. Mooney & Sons. The terrazzo and marble tile work was done by the Dominion Flooring and Tile Company, Montreal.

WESTERN CANADA

The National Paving and Contracting Company, Limited, Winnipeg, have a contract running into $193,000 for asphaltic concrete paving work at Fort William.

A technical school, estimated to cost $300,000, is to be erected at Medicine Hat, Alta. The plans have been drawn and operations are to start as soon as the necessary debentures have been sold.

Sewer contracts amounting to nearly $200,000 have been awarded by the city of Edmonton, the work being divided between C. L. De Vall, the Edmonton Contracting Company and the City Construction Department.

The Alberta Clay Products Company, Medicine Hat, are considering the matter of an extension to their plant. Either they will build a large addition which will double the capacity of the present plant or they will build another plant at Dunmore, Alta.

Construction has commenced on the walls of the Manitoba Parliament Buildings now being erected at Winnipeg at a cost of $2,000,000. The architect is Mr. F. W. Simon and the general contractors are Messrs. Thos. Kelly & Sons, both of Winnipeg.

Edmonton's newest municipally-owned public utility is a paving plant, to be established next month at a cost of $37,000. The entire paving programme for this year involves a total expenditure of more than $1,500,000, part of which will be financed by the Hudson's Bay Company.

The proposed branch line from Round Lake to Girouard, Alta., will not be constructed this year, according to an announcement made by Mr. J. D. McArthur at Edmonton a few days ago. He explained that a charter and guarantee would first have to be obtained from the government before a line could be constructed.

At Edmonton, Alta., good progress is being made on the ten-storey store and office building which is being erected on McDougall Avenue for K. McLeod at a cost of $450,-

000. The walls are now up five storeys. The architect is Mr. J. K. Daw and the general contractors are Messrs. Olson & Johnson, both of Edmonton.

At Chilliwack, B.C., rapid progress is being made on the Harrison River bridge being constructed by the C. P. R. The structure is made to accommodate double tracks and is 950 feet long. The superstructure is nearing completion, the swing span having been installed and work well advanced from both ends. The Pitt River bridge, a similar structure but one much larger, being 1,750 feet in length, will be the largest of its kind in British Columbia. The swing span is 276 feet in length and weighs 650 tons.

The excavation and grading contract of the Marine & Fisheries site on the Songhees Reserve, B.C., is coming on satisfactorily. The contractors, Messrs. Parks, Tupper & Kirkpatrick, anticipate that the whole of the work will be completed by the end of July. The contract calls for the excavation of about 25,000 cu. yds. of material on the foreshore of the government site, and the construction of a wharf 650 ft. long. Some rock is being encountered in excavating, in connection with which a Marion steam shovel is operating, but it is not anticipated that the presence of rock will seriously effect progress on the contract.

Grading on the British Columbia division of the Canadian Northern Pacific Railway has been completed with the exception of about fifteen miles on the sections between Railhead, 121 miles north of Kamloops, and the terminal of the rails from the eastern end, six miles west of the Yellowhead Pass. Mr. S. H. Sykes, assistant chief engineer of the company, has announced that the bridge over the Canoe river, ten miles east of Albreda summit, has been completed, that construction work will be started at an early date on the bridge over Lion Creek, and that operations are well advanced on the entire section along the North Thompson river.

The whole of the Pacific Great Eastern Railway is now under contract according to Mr. J. W. Stewart, president of the line, who was interviewed recently in Victoria. Grading is in progress along the whole right-of-way from Squamish to Fort George and will practically be finished this year. Mr. Stewart reports that a uniform force of no less than six thousand will be maintained on the work for the balance of the year. In this connection he mentioned that there was this season an ample supply of labor, this condition being mainly due to the fact that the Pacific Great Eastern is the only railway undertaking at present under way in the Province, both the Grand Trunk Pacific and the Canadian Northern Pacific being practically finished.

Constructional activities at Regina are proceeding satisfactorily—so much so, in fact, that there is more building in progress just now than there was at the corresponding time last year. Of the various projects of which we have heard mention may be made of the proposed new office building for the Royal Bank. The Canadian International Light Company, which is capitalized at $100,000, has entered into an agreement with the city of Regina to establish a factory and employ not less than twenty-six hands at the outset. T. A. McAuley, of the Coste-McAuley Syndicate, has been in Regina completing negotiations for the supply of natural gas to the city. The ultimate aim of the syndicate is to supply natural gas to the three largest Saskatchewan cities. There is considerable interest in this project, as it is felt that cheap gas at Regina would prove of inestimable value to local industrial concerns. Mr. A. M. Lloyd, a local architect, has been instructed to prepare plans for a new building for the Regina Labor Temple Company, which is capitalized at $50,000.

Trade Notes

The Link Belt Company, Chicago, in their new book, No. 195, illustrate and describe installations of elevating and conveying machinery for handling newspapers, magazines, and so on, in publishing houses and printing establishments. The cuts are particularly illuminating as to the possibilities of equipment and the book should find its way freely into the hands of engineers, architects and newspaper men.

An effective safety device for the prevention of injury to industrial workers operating power punching presses is described in a booklet just received from Canadian Yale & Towne, Limited, St. Catharines, Ont. The inventor is Mr. R. C. Lewis, of the above company. The device is not patented and it is hoped that it will be adopted largely. It can be installed at small cost and with the exercise of a little ingenuity it can be adapted to any style of press in use.

A booklet devoted to Solvay Granulated Calcium Chloride deals with the efficiency of this product as a dust layer. This product is applied both by machine and hand. For small quantities it can be spread with a shovel and for large areas with a simple spreading machine. When applied to the road it soon becomes incorporated with the surface, which it keeps in a smooth, slightly damp and compact condition. Economy and efficiency are its outstanding claims. The manufacturers are the Semet-Solvay Company, Syracuse.

Many evidences of the efficiency of Ceresit waterproofing are contained in an interesting catalogue just received from the Ceresit Waterproofing Company, Chicago. The catalogue is made up of five booklets, the first being devoted to a scientific explanation of the composition and operation of Ceresit, the second to an enumeration of tests by recognized authorities, the third to a selection of photographs showing where Ceresit has been used, the fourth to testimonials from satisfied users of Ceresit, and the fifth to an explanation of a demonstration test of Ceresit.

Messrs. Wadsworth, Howland & Company, Inc., Boston, announce their removal about January 1, 1915, to more commodious quarters at 139-141 Federal street (Boston). The larger area of floor space covered by these stores will enable the firm to carry under one roof the heavy stock of all goods now carried in their storehouse at 208-210 Milk Street and in their present main store at 82-84 Washington Street, besides giving them excellent facilities for the receipt and delivery of goods. The new location is close to the heart of the shopping and wholesale hardware district and the proximity of the stores of the South Terminal Station is an important advantage. Messrs. Wadsworth, Howland & Company are the manufacturers of Bay State Brick and Cement Coating, a waterproofing material which has already been described in detail in these columns.

American Road Builders' Convention

The proceedings of the Tenth Annual Convention of the American Road Builders' Association (Philadelphia, December 9-12, 1913) comprise a concise record of a meeting of great interest and importance to road-builders and municipalities. A number of the papers were published in the Contract Record shortly after the convention. These are all presented in the Proceedings and are accompanied in each case by the discussions which ensued. Among the interesting features of the Proceedings are the various reports, the revised constitution of the Association, the names of the officers for 1914, and the list of members revised to date. The Secretary of the American Road Builders' Association is Mr. E. L. Powers, 150 Nassau Street, New York City.

TH
1
E54
v.28
pt.1
~~Physical &~~
~~Applied Sci.~~
~~Serials~~
Engineering

Engineering and contract
record

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

ENGIN STORAGE